AUGUST-DECEMBER 2003 VOLUME XXXV, NUMBER 5

TSUNAMI NEWSLETTER

International Tsunami Information Center

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The Nineteenth Session of the UNESCO/IOC ICG/ITSU was held September 29-October 3, 2003 in Wellington, New Zealand. See pages 19-20 for summary.

SUMMARY OF EARTHQUAKES IN THE PACIFIC

Occurring August-December 2003

With surface wave or moment magnitude (M_w) greater than or equal to 6.5 and a depth no greater than 100 km, or an event for which a Tsunami Information Bulletin (TIB) or Regional Watch Warning (RWW) was issued. Epicenter, M_S, and M_W from USGS National Earthquake Information Center (NEIC, G); M_W and centroid depth from Harvard (H); M_W from PTWC at action time.

DATE	TIME (UTC)	LOCATION	LATITUDE	LONGITUDE	DEPTH (km)	M_W	M_S	PTWC ACTION	ACTION TIME (UTC)	Tsunami? Damaging?
Aug 4	4:37	Scotia Sea	60.555 S	43.492 W	15	7.5 (G,H) 7.7 (P)	7.4	TIB	5:22	NO NO
Aug 21	12:13	South Island, New Zealand	45.124 S	167.172 E	34	7.1 (G) 7.2 (H) 7.3 (P)	7.5	TIB	12:31	YES NO
Sep 25	19:50	Hokkaido, Japan	41.775 N	143.904 E	28	8.1 (G,P) 8.3 (H)	8.1	RWW -001 Supplement -002 Supplement -003 Cancellation -004	20:07 20:27 21:04 22:13	YES YES
Sep 25	21:08	Hokkaido, Japan	41.755 N	143.626 E	48	7.3 (G) 7.4 (H)	7.3	--	--	NO NO
Oct 8	9:07	Hokkaido, Japan	42.612 N	144.559 E	37	6.6 (H,G,P)	6.6	TIB	9:18	NO NO
Oct 31	1:06	Off East Coast of Honshu, Japan	37.830 N	142.629 E	15	7 (H, G) 6.7 (P)	6.8	TIB	1:22	YES NO
Nov 17	6:43	Rat Islands, Aleutian Islands	51.128 N	178.745 E	22	7.8 (H) 7.7 (G) 6.9 revised to 7.5 (P)	7.2	TIB-001 TIB-002	6:54 7:09	YES NO
Nov 18	17:14	Samar, Philippine Islands	12.036 N	125.435 E	38	6.5 (H,G) 6.7 (P)	6.5	TIB	17:35	NO NO
Nov 25	20:20	New Britain Region, PNG	5.539 S	150.838 E	45	6.6 (H,G) 6.7 (P)	6.4	TIB	20:43	NO NO
Dec 5	21:26	Komandorsky Islands Region	55.500 N	165.763 E	15	6.7 (H,G) 7.0 (P)	6.5	TIB	21:40	NO NO
Dec 10	4:38	Taiwan	23.055 N	121.330 E	32	6.8 (H,G) 6.9 (P)	6.7	TIB	4:54	NO NO
Dec 22	19:16	Central California, USA	35.706 N	121.102 W	15	6.5 (H) 6.4 (G) 6.8 (P)	6.4	TIB	19:23	NO NO
Dec 25	20:43	Loyalty Islands Region	22.270 S	169.490 E	16	6.5 (H) 6.4 (G) 6.7 (P)	6.3	TIB	21:07	NO NO
Dec 26	21:26	Loyalty Islands Region	22.319 S	169.295 E	15	6.8 (H,P) 6.7 (G)	6.8	TIB	21:48	NO NO
Dec 27	16:01	Loyalty Islands Region	22.033 S	169.650 E	24	7.3 (H,P) 7.2 (G)	7.1	TIB-001 TIB-002	16:19 19:49	YES NO
Dec 27	22:55	Loyalty Islands Region	21.764 S	169.744 E	20	6.3 (H) 6.4 (G) 6.8 (P)	6.4	TIB	22:55	NO NO

SOUTH ISLAND, NEW ZEALAND, 21 August 2003

An earthquake of magnitude Mw 7.2 (HRV) occurred at 12:13 UTC on 21 August 2003, just offshore from the South Island near Secretary Island, Fiordland, and 750 km southwest of Wellington, New Zealand. The earthquake was one of the largest near-land earthquakes in many years. A M5.9 (GS) aftershock occurred two hours later. Minor damage occurred in the Queenstown-Te Anau area, and extensive landslides and rockslides were observed in the Fiordland National Park. The earthquake was felt as far north as Wellington on North Island and to the west in Sydney, Australia.

A small, 30 cm trough-to-peak tsunami (period 25 minutes) was recorded at Jackson Bay in Westland, New Zealand nearly two hours after the earthquake, and a 15 cm seiche, consistent with the tsunami travel time across the Tasman Sea, was observed at Port Kembla, Australia, three hours after the earthquake. The largest tsunami waves arrived at Jackson Bay much later than the predicted tsunami travel time, suggesting that the tsunami was generated from the largest aftershock (M5.9) that occurred two hours after the main earthquake. Hydrodynamic modelling by James Chittleborough of the Australia National Tidal Facility (NTF) using a realistic seismic source suggests instead, however, that the substantially-delayed arrival of the largest tsunami waves at Jackson Bay may be similar to the behaviour of the 1992 Cape Mendocino earthquake, which generated a tsunami characterized by both coastal trapped edge wave and non-trapped tsunami modes that propagated north and south along the U.S. West Coast (*Gonzalez, et al., Pure and Applied Geophysics, 144, 409–426, 1995*). Gonzalez et al. (1995) showed that non-trapped tsunami waves may strike the coast in the first few minutes, but then be followed hours later by slow-moving, but energetic edge waves trapped along the coast. The New Zealand Institute of Geological and Nuclear Sciences also reported the occurrence of a very local, 5 m high tsunami that was triggered by a landslide that cascaded into Gold Arm in Charles Sound.

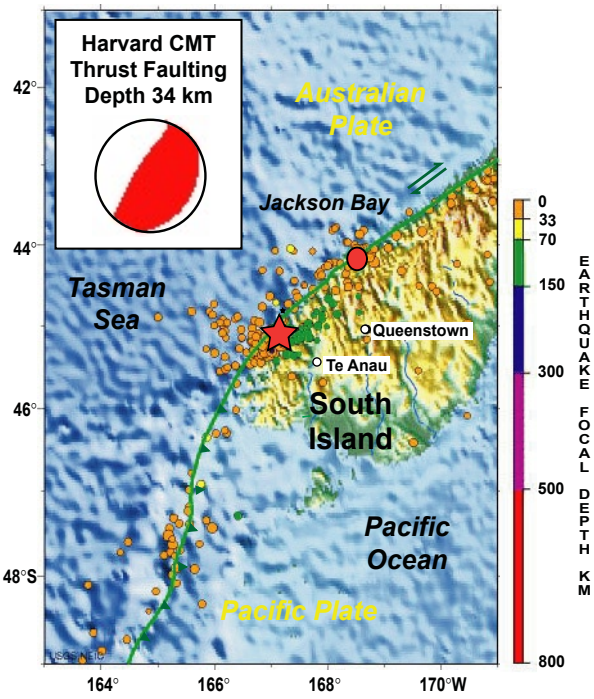


Figure 1. Historical seismicity (1990 to present) from USGS/NEIC. The earthquake (red star) occurred in the transition zone from strike-slip to convergent plate motion where the Australian plate is being subducted beneath the Pacific plate. Thrust faulting at 34 km centroid depth (Harvard CMT) is indicated. The Fiordland region is one of the more seismically active parts of New Zealand; three other shallow earthquakes have occurred in the vicinity in the last 15 years (1989, 1993, 2000). A 30 cm tsunami was observed at Jackson Bay (red dot).

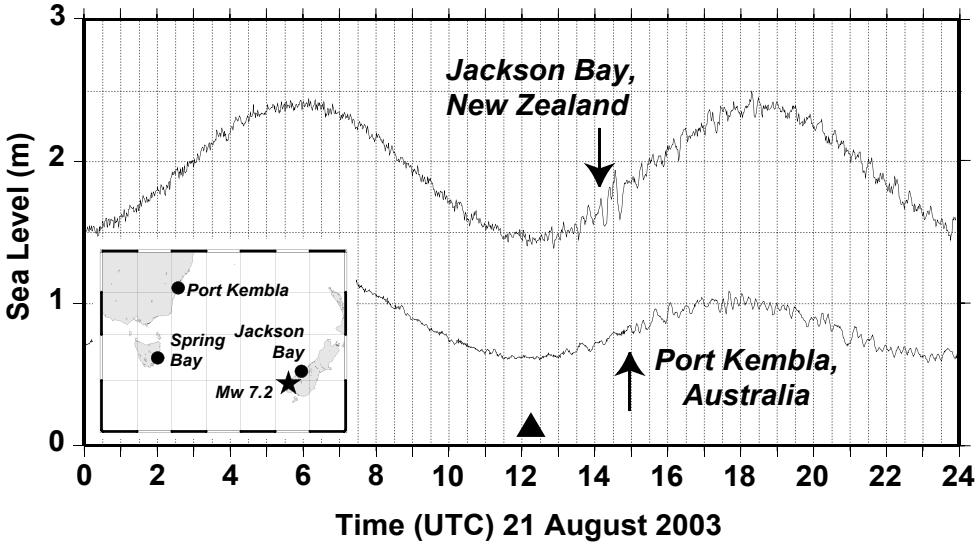


Figure 2. Sea-level data at Jackson Bay, New Zealand, 260 km north of the epicenter (top) and Port Kembla, Australia (bottom) as recorded on the SEAFRAME tide gauges operated by the NTF Australia. Data sampled at 1-minute intervals. The time of the main earthquake is indicated by the triangle. No notable tsunami was observed at Spring Bay, Australia.

HOKKAIDO, JAPAN, 25 September 2003

Summarized from reports by the USGS/NEIC, Japan Meteorological Agency (Noritake Nishide, Director, Earthquake & Tsunami Observation Div., Seismological & Volcanological Dept., 1-3-4, Otemachi, Chiyoda-ku, Tokyo 100-8122, noritake.nishide@met.kishou.go.jp), and 2003 Tokachi-oki Tsunami Survey Team (Yuichiro Tanioka, Yuichi Nishimura, Kazuomi Hirakawa, Fumihiko Imamura, Ikuo Abe, Yoshi Abe, Kazuya Shindou, Hideo Matsutomi, Tomoyuki Takahashi, Kentaro Imai, Kenji Harada, Yuichi Namegawa, Yohei Hasegawa, Yutaka Hayashi, Futoshi Nanayama, Takanobu Kamataki, Yoshiaki Kawata, Yoshinobu Fukasawa, Shunichi Koshimura, Yasunori Hada, Yusuke Azumai, Kenji Hirata, Akiyasu Tamikawa, Akifumi Yoshikawa, Toru Shiga, and Seiichi Masaka). *Institute of Seismology and Volcanology, Hokkaido University, N10W8 Kita-ku, Sapporo 060-0810, Japan, tanioka@eos.hokudai.ac.jp.*

A great earthquake of magnitude Mw 8.3 (HRV) occurred at 19:50 UTC on 25 September 2003, off of southern Hokkaido, Japan (Figures 1 and 2). At least 589 people were injured, and extensive structural and road damage, power outages, and landslides were observed in southeastern Hokkaido. The earthquake was felt strongly in Hokkaido, and in northern and much of central Honshu, and as far south as Tokyo 765 km to the south-southwest. Moment tensor solutions indicate thrust faulting (28 km centroid depth from Harvard) on the plate interface between the overriding North American Plate and the subducting

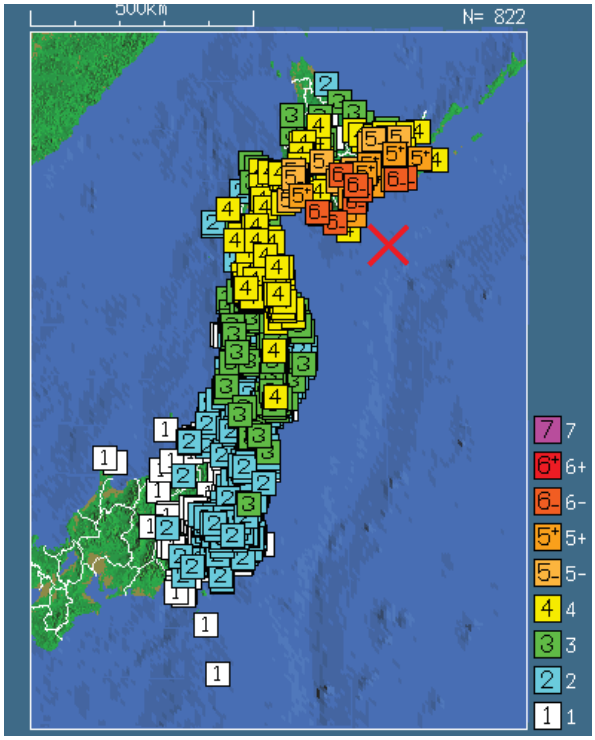


Figure 2. Distribution map of seismic intensity, as recorded by about 3400 Seismic Intensity Meters thoroughout Japan. Scale used is JMA Seismic Scale.

HISTORICAL SEISMICITY, 1900-2002

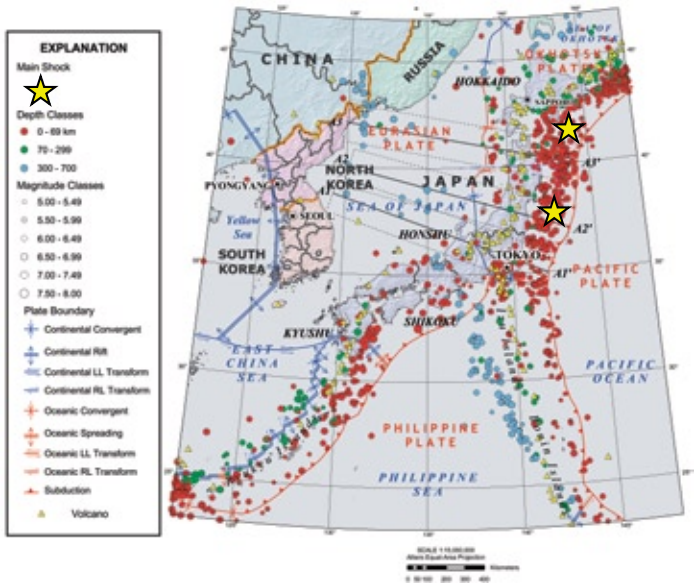


Figure 1. Historical seismicity in this region (USGS/NEIC). The two earthquakes (shown as yellow stars) occurred in the area where the Pacific plate subducts beneath the Kurile Trench (25 September) and Japan Trench (31 October).

HISTORICAL TSUNAMIGENIC EARTHQUAKES

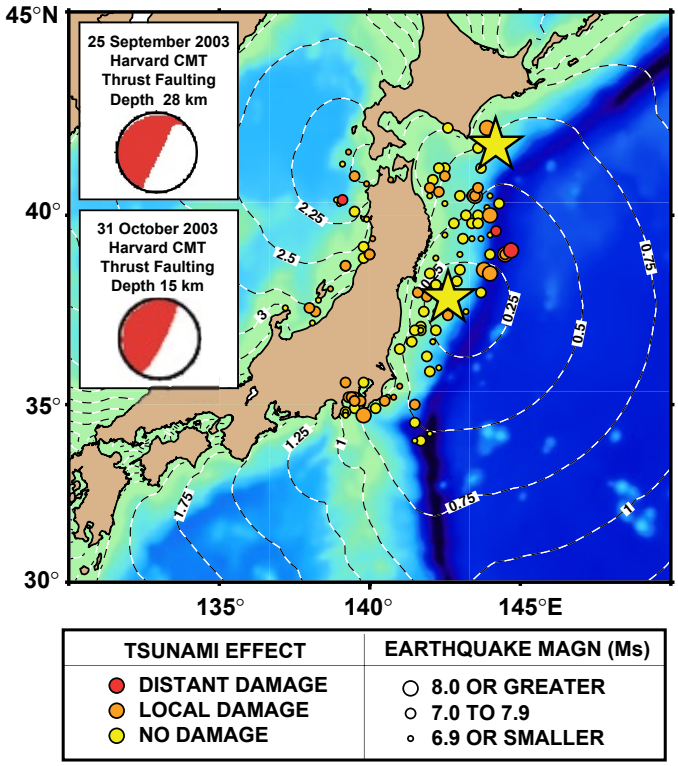


Figure 3. Historical earthquakes that have generated tsunami in this region. Tsunami travel time contours at 0.25 hour intervals. Centroid Moment Tensor solutions indicate shallow thrust faulting along a strike parallel to the trench axis. Yellow stars show epicenters of the two earthquakes.

HOKKAIDO, JAPAN, *continued*

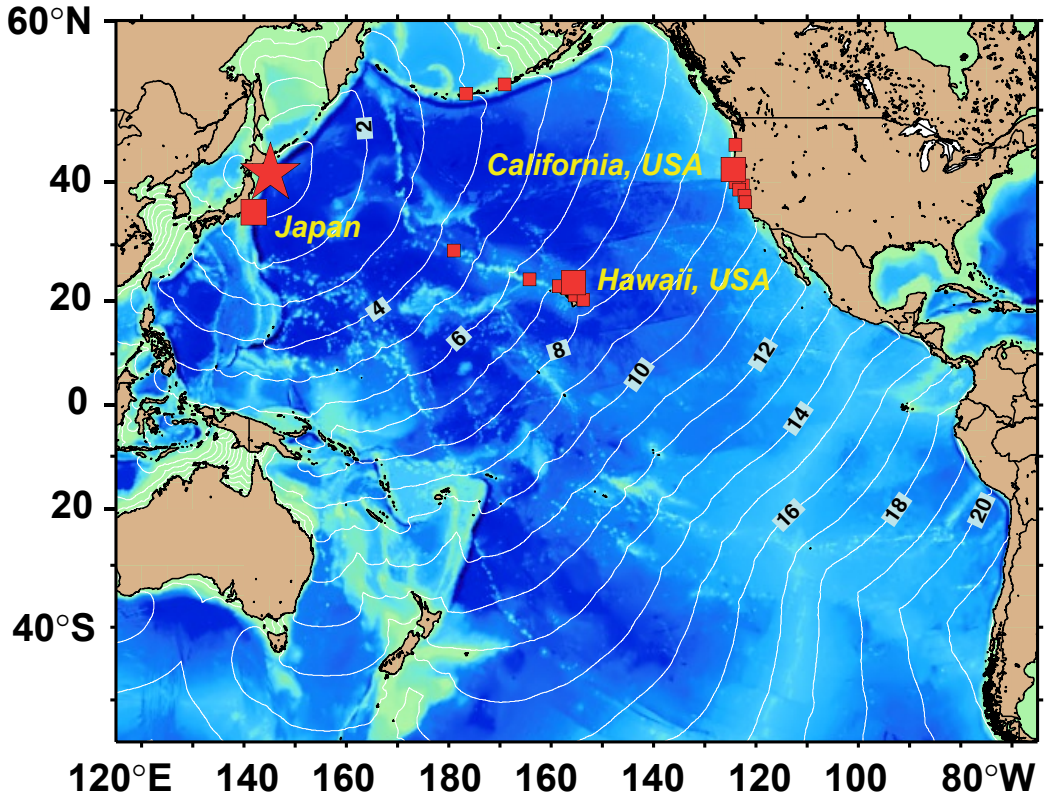


Figure 4. Pacific-wide tsunami travel times for 25 September 2003 earthquake (red star). Contour interval is one hour. Squares show locations of sea level stations listed in Table 2, and large squares show stations for which data are shown in Figures 5 and 6; many stations recorded the tsunami in Japan, but are depicted in this map by only one large square.

Pacific plate. This region has experienced a number of damaging earthquakes, including the M8.1 1952 Tokachi-oki earthquake which killed 31, injured 72, and generated a 6.5 m maximum run-up at Akkeshi, Hokkaido, the M7.9 1968 earthquake which caused USD $25 million in damage, and the M7.6 1993 earthquake which injured 614 people (Figure 3).

The JMA issued a tsunami warning for the Pacific coast of Hokkaido and a tsunami advisory for Aomori, Iwate, Miyagi and Fukushima Prefecture at 19:56 UTC (see JMA operations timeline, p.10). The tsunami was observed along the Pacific coast of Hokkaido and in the Tohoku region of northern Honshu and throughout the Pacific (Figures 4-6, Tables 1-2). The Tokachiko tide gauge recorded a maximum wave height of 254 cm at 20:24, and the water level gauge installed 11 km upstream on the Tokachi River also recorded the tsunami wave. Immediately after the earthquake, tsunami surveys were carried out by the JMA and additionally by tsunami researchers from all over Japan (Figures 7 and 8). (T*anioka et al., Slip distribution of the 2003 Tokachi-oki earthquake estimated from the tsunami waveform inversion*, submitted to *Earth Planets Space*, *2003*). The survey teams covered all coasts of southern Hokkaido and eastern Tohoku region. The tsunami was also observed on a tsunami-meter (pressure gauge) located about 0.8 degrees northeast of the epicenter (Figure 6d and 6e), and on two ocean-bottom tsunami-meters located three degrees south of the epicenter off of Kamaishi, Iwate, Honshu Island. The JMA and the multi-agency Tsunami Survey Team comprised of university scientists and several government agencies reported the largest tsunami wave heights to be 4 m on the east side of Cape Erimo, near Bansei-onsen, and locally at Mabiro (Figures 7 and 8). The tsunami height distribution of the 2003 Tokachi-oki earthquake is clearly different from that of the 1952 Tokachi-oki earthquake, suggesting that the source processes or the tsunami generation of the 1952 Tokachi-oki earthquake was different (*Hirata et al.*, *Source processes of the Tokachi-oki earthquake on September 26, 2003, inferred from teleseismic body waves*, submitted to *Earth Planets Space*, 2003).

Tsunami waveforms from nine tide gauges and two ocean bottom tsunami-meters in southern Hokkaido and eastern Tohoku were used to invert for the slip distribution from the event (*Tanioka et al., 2003*), The largest slip was estimated to be 3.9 m on the subfault located off Hiroo, with a second 3.1-m slip estimated for the subfault located near Kushiro. The slip distribution is similar to that estimated by Yamanaka and Kikuchi using the teleseismic body waves (*Hirata, et al., 2003*).

There was also wide concern among the Japanese that the coastal evacuations from the tsunami warnings were not taken seriously. Initial reports collected by an Earthquake Engineering Research

HOKKAIDO, JAPAN, *continued*

Institute Survey Team were that the evacuation rate was only about 50%. In response, the Japanese government has convened a research team to identify ways to improve the tsunami warning system in Japan. This team visited Hawaii in November to learn more about the Hawaii Tsunami Warning System from the PTWC and State emergency officials (see article in this issue, page 17).

Further information and data files for this event can be found at *http://www.prh.noaa.gov/itic/tsunami_events/recent_data/recent_data.html*.

Tide station name	Arrival (local time)	Initial wave height*	Maximum wave height*
Nemuro	5:54	(+) 8 cm	19 cm
Nemuroshi Hanasaki	5:27	(+) 90 cm	90 cm
Kiritappu	5:23	(+) 43 cm	130 cm
Akkeshi	5:05	(+) 17 cm	114 cm
Kushiro	5:06	(+) 102 cm	118 cm
Tokachiko	5:06	(+) 254 cm	254 cm
Urakawa	5:07	(+) 20 cm	129 cm
Mitsuishi	--	--	53 cm
Shizunai	--	--	53 cm
Tomakomai higasiko	5:45	(+) 45 cm	109 cm
Tomakomai nishiko	5:49	(+) 32 cm	96 cm
Shiraoi	5:36	(+) 44 cm	64 cm
Muroran	6:03	(+) 25 cm	26 cm
Mori	6:06	(+) 23 cm	31 cm
Usujiri	5:48	(+) 22 cm	50 cm
Hakodate	6:05	(+) 30 cm	78 cm
Hachinohe	5:44	(+) 63 cm	99 cm
Mutsushi Sekinehama	5:39	(+) 35 cm	48 cm
Miyako	5:34	(+) 57 cm	57 cm
Ofunato	5:44	(+) 22 cm	22 cm
Kamaishi	5:40	(+) 42 cm	42 cm
Oshikacho Ayukawa	5:59	(+) 16 cm	27 cm
Iwakishi Onahama	6:15	(+) 12 cm	18 cm

Table 1. Tsunami wave heights reported by the JMA. Heights measured above the predicted tide level. Arrival time (local time) is Japan Standard Time, JST.

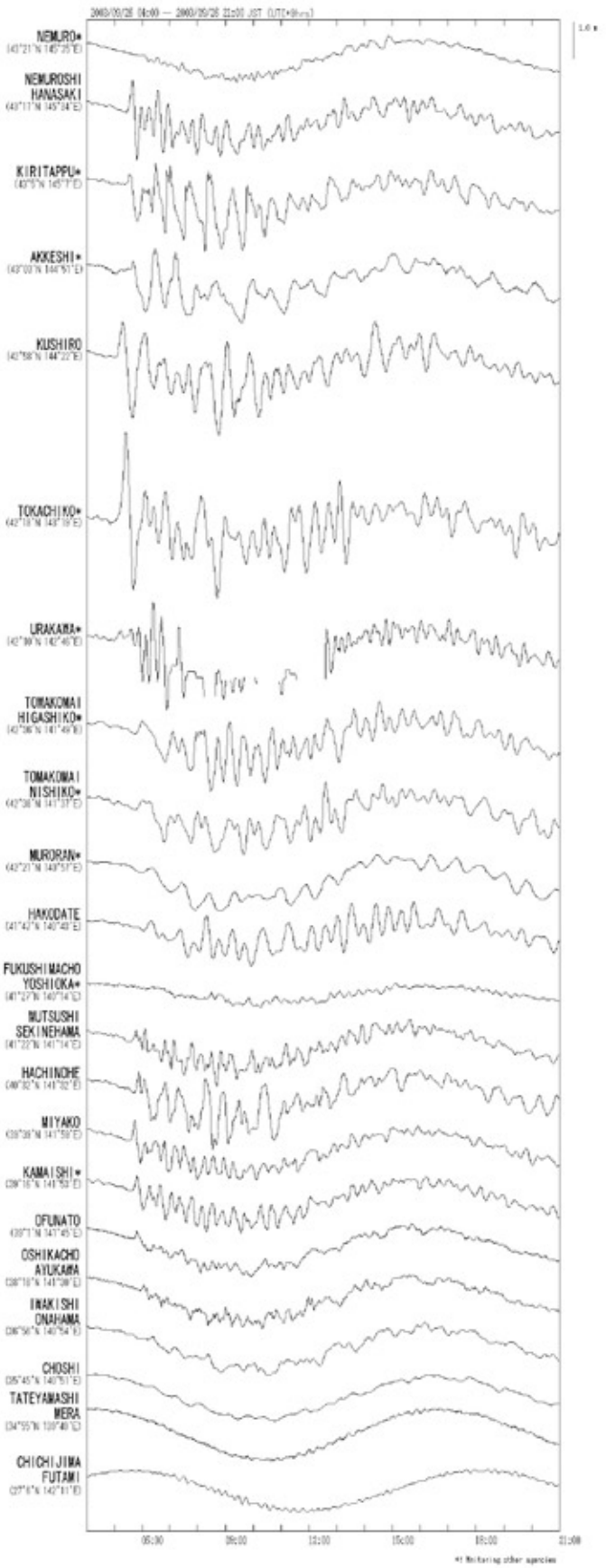
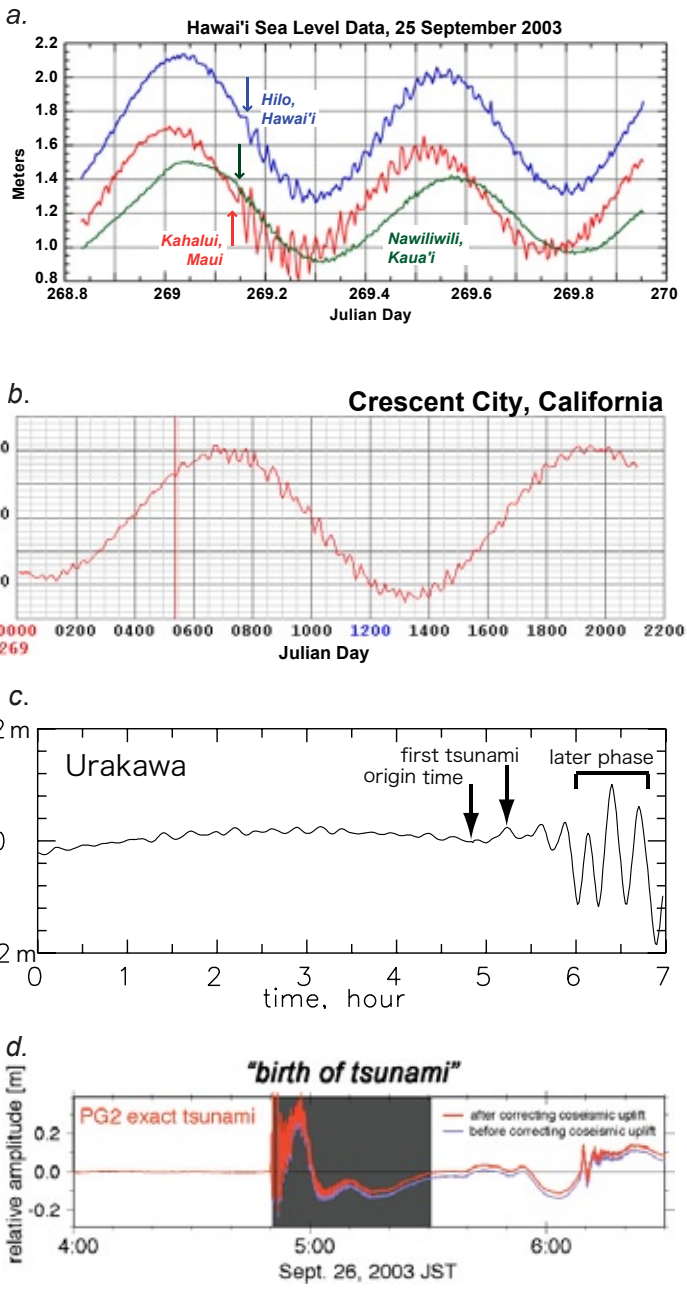


Figure 5. Tsunami recorded by tide stations in Japan. Arrival times (JST) and tsunami heights are reported in Table 1. Data courtesy of JMA.

HOKKAIDO, JAPAN, *continued*

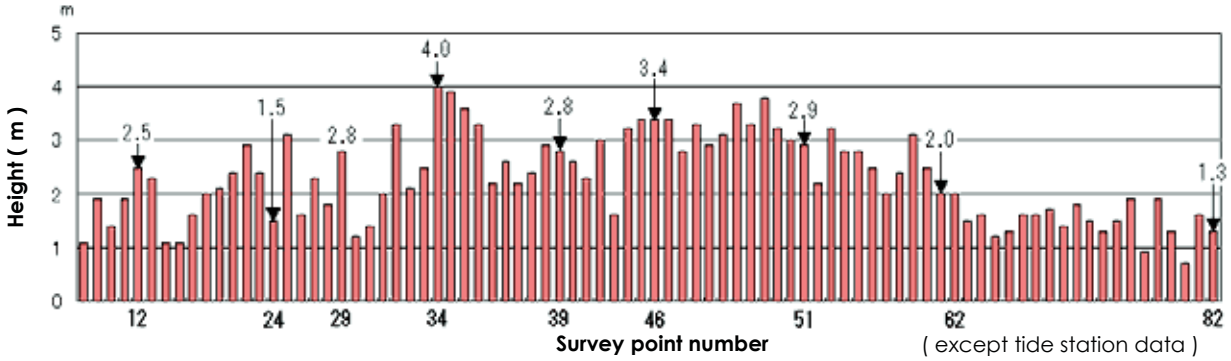


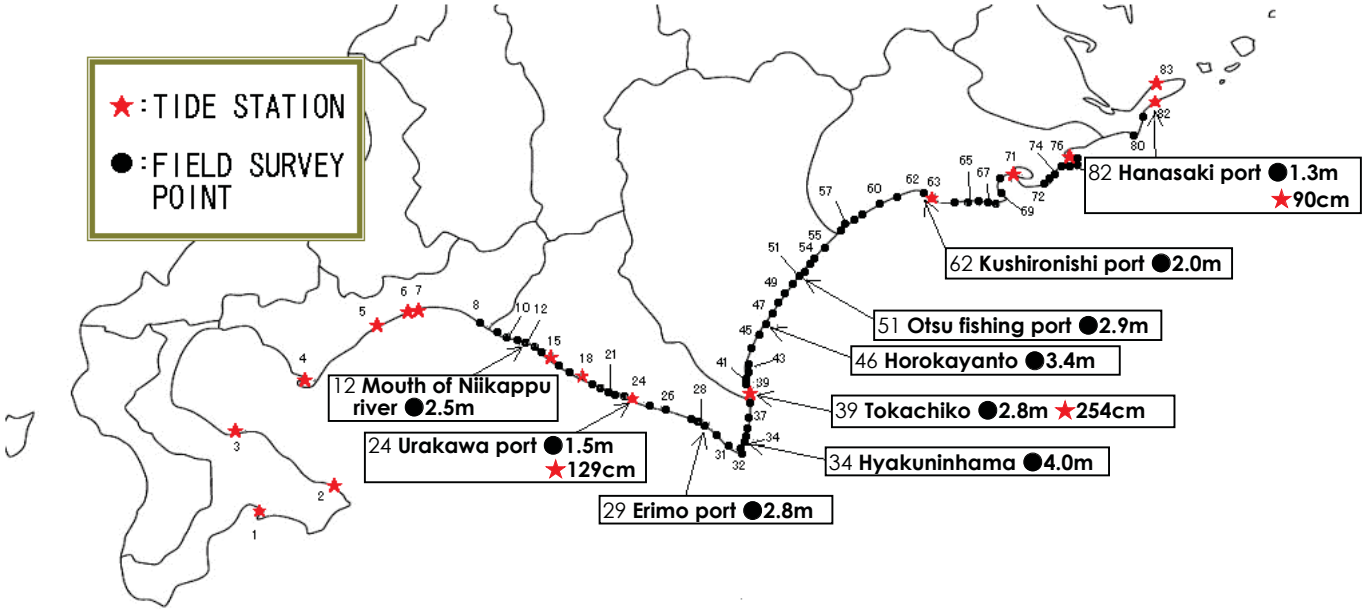
Station Location	Height (cm)	Arrival time (UTC)	Sample Interval (min)
Hanasaki, Japan	213	2026 9/25	6
Ofunato, Japan	35	2047 9/25	6
Midway Island	6	0050 9/26	6
French Frigate Shoals, Hawaii	4	?	6
Kalaupapa, Hawaii	~10	0315 9/26	0.25
Kawaihae, Hawaii	10	0340 9/26	6
Honolulu, Hawaii	6	0328 9/26	6
Kahului, Hawaii	40	0330 9/26	6
Hilo, Hawaii	13	0345 9/26	6
Honokahau, Hawaii	8	0342 9/26	0.25
Adak, Alaska	8	0010 9/26	0.25
Dutch Harbor, Alaska	7	0133 9/26	0.25
Port Orford, Oregon	7	?	6
Crescent City, California	35	0530 9/26	6
Humboldt Bay, California	8	?	6
Point Arena, California	4	0520 9/26	6
Point Reyes, California	6	?	6
Pt. San Luis, California	6	?	6
San Francisco, California	5	0615 9/26	6
Monterey, California	9	0540 9/26	6

Table 2. Tsunami wave heights reported by the WC/ATWC. Heights represent maximum peak-to-trough height in centimeters. Arrival time is the actual tsunami arrival time on gauges where it could be determined.

Figure 6. a. Tsunami recorded by sea level stations in Hawaii. Data courtesy of the PTWC. b. Tsunami recorded at Crescent City, California, USA. Data courtesy of NOAA National Ocean Service and the WC/ATWC. c. Tsunami recorded at the tide station in Urakawa, Japan showing that the first-arriving tsunami wave was followed an hour later by edge waves four times larger that propagated from Cape Erimo along the west coast of the Hidaka area. (Tanioka et al., 2003). d. "Birth of Tsunami" as recorded by the JAMSTEC cabled seafloor observatory off the southeastern coast of Hokkaido. Station PG2 was located about 0.8 degrees from the epicenter. e. Station PG2 was located about 0.8 degress from the epicenter (star). The transient thermal response signal, and estimated value of cosesmic uplift have been removed. Data from Hirata et al., 2003, as presented at 2003 Fall AGU meeting (see related article, p. 28).

HOKKAIDO, JAPAN, *continued*





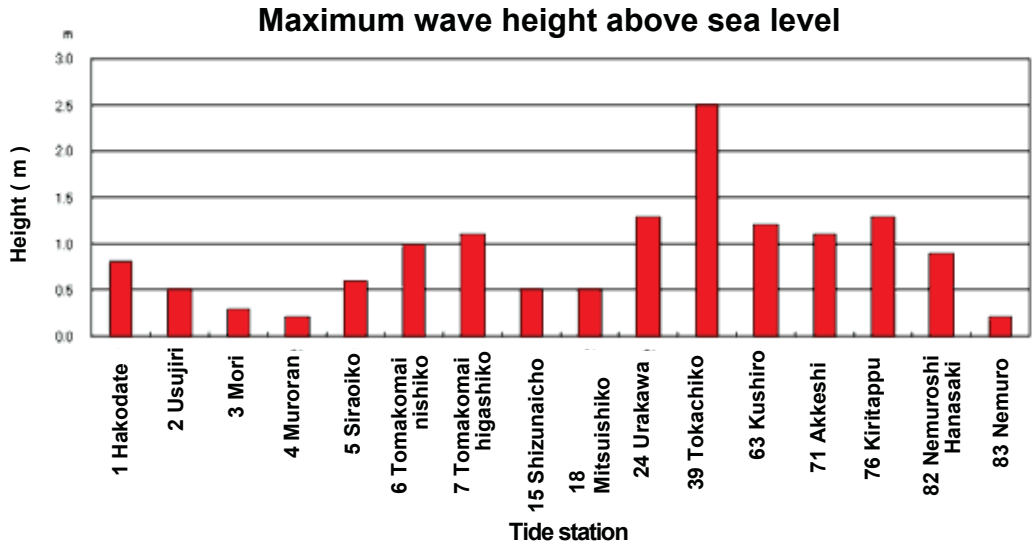


Figure 7. Tsunami Survey results reported by JMA.

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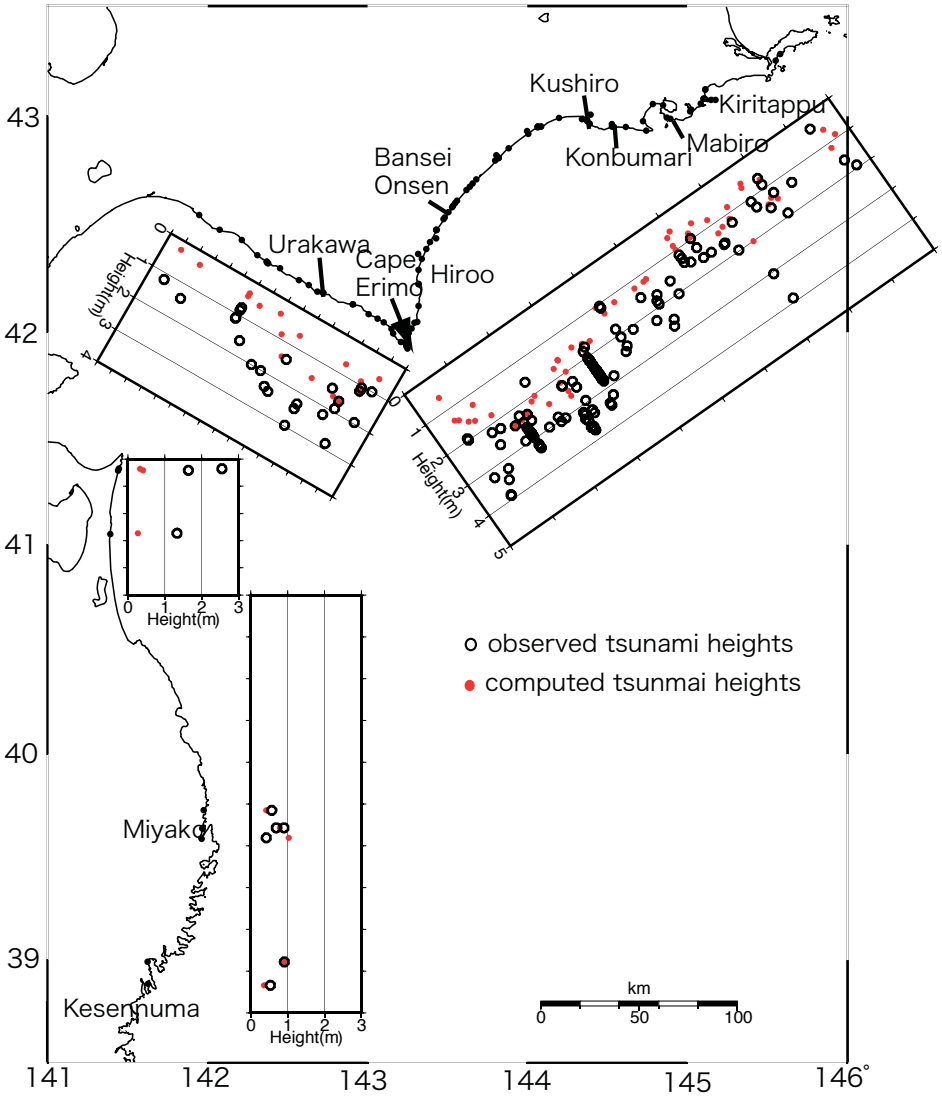


Figure 8. Tsunami wave heights collected by multi-agency Japanese Survey Team within six days after the earthquake. The quick survey was important because most of the tsunami deposits were located in the surf zone of this moderate tsunami, and thus subject to disturbances by subsequent high surf and high tides. The observed tsunami heights (black circles) were measured from the various objects deposited by the tsunami, water lines left on buildings, and from eyewitness reports, and corrected for tide levels using the level at the time of the maximum tsunami. Computed heights (red dots) were calculated using a finite difference method to solve the linear long-wave equations with an initial vertical displacement computed from the slip distribution from seismic data determined by Yamanaka and Kikuchi (2003). The computed heights slightly underestimate the observed heights because of the large grid size used in the simulation. Data from Tanioka, et al. (2003).

a.

b.

Figure 9. a. Dr. Kenji Hirata during survey of tsunami deposits from the 2003 Hokkaido tsunami. Photo from Tanioka et al., (2003). b. Boat overturned by tsunami. Photo courtesy of JMA.

JMA OPERATIONS TIMELINE -Japan Standard Time- 26 September 2003

04:50 Origin time

04:56 Issued Tsunami Forecast Bulletins:
<Tsunami>
Eastern part of Hokkaido's Pacific Coast, Central part of Hokkaido's Pacific Coast
<Tsunami Attention>
Western part of Hokkaido's Pacific Coast, Japan Sea Coast of Aomori Prefecture, Pacific Coast of Aomori, Iwate, Miyagi, and Fukushima Prefectures.

04:57 Issued Tsunami Information Bulletins: (Estimated time of arrival and estimated height for each block)

<Tsunami>		
Eastern part of Hokkaido's Pacific Coast	5:00	1.0m
Central part of Hokkaido's Pacific Coast	5:00	2.0m
<Tsunami Attention>		
Western part of Hokkaido's Pacific Coast	5:20	0.5m
Japan Sea Coast of Aomori Prefecture	5:50	0.5m
Pacific Coast of Aomori, Prefecture	5:10	0.5m
Iwate Prefecture	5:20	0.5m
Miyagi Prefecture	5:30	0.5m
Fukushima Prefecture	6:00	0.5m

04:57 Issued Tsunami Information Bulletin (highest tide time and estimated time of initial wave arrival for some points in each block)

05:25~08:28 Issued Tsunami Information Bulletins (tsunami observations)

09:00 Issued Tsunami Forecast Bulletin (downgraded from <Tsunami> to <Tsunami Attention> for eastern and central parts of Hokkaido's Pacific Coast)

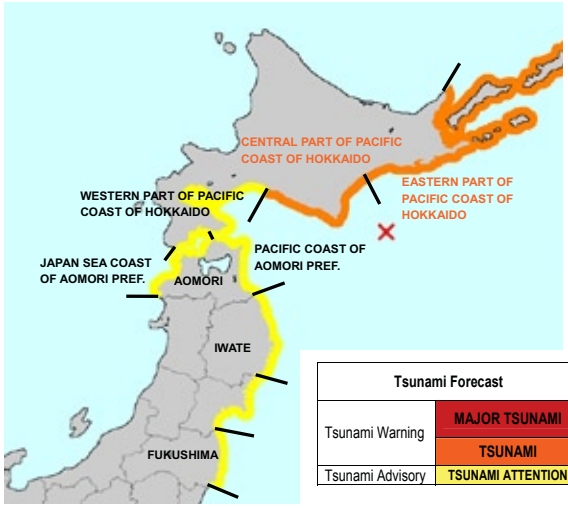
09:30 Issued Tsunami Information Bulletins (tsunami observations)

15:00 Issued Tsunami Forecast Bulletin (Cancellation for Miyagi and Fukushima Prefectures)

16:30 Issued Tsunami Forecast Bulletin (Cancellation for Japan Sea Coast of Aomori Prefecture, Pacific Coast of Aomori, and Iwate Prefecture)

18:30 Issued Tsunami Forecast Bulletin (Cancellation for eastern and central parts of Hokkaido's Pacific Coast)

18:33 Issued Tsunami Forecast Bulletin (tsunami observations)



Tsunami Forecast		Value of tsunami height to be issued
Tsunami Warning	MAJOR TSUNAMI	Either: 3m, 4m, 6m, 8m or over 10m
	TSUNAMI	1m or 2m
Tsunami Advisory	TSUNAMI ATTENTION	0.5m

EARTHQUAKE OFF HONSHU, 31 October 2003

An earthquake of magnitude Mw 7.0 (HRV) occurred at 01:06 UTC on 31 October 2003, off the east coast of Honshu, Japan (Figure 1). The earthquake was felt in much of the Tohoku district and as far away as Tokyo 350 km to the southwest. A small tsunami was recorded by four sea level stations along the Tohoku coast, with the maximum height of 32 cm recorded at the Oshikacho Ayukawa station (Figures 1 and 2). Although non-destructive, the observed tsunami was larger than that expected by the Japan Meteorological Agency due to the overestimation of focal depth given the shallowness of the plate boundary in this region, and the underestimation of the earthquake's magnitude. See 25 September 2003 event, Figures 1 and 3 (page 4), for a summary of the historical seismicity and locations of tsunamigenic earthquakes for this region.

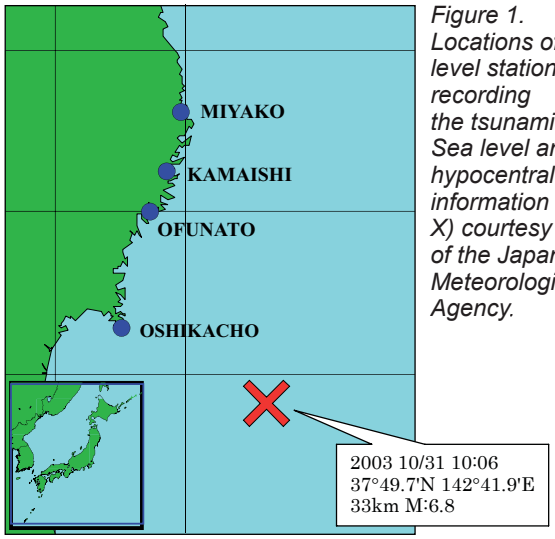
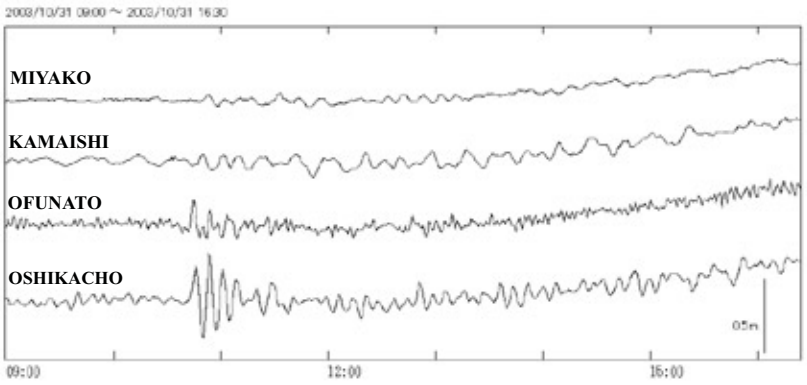


Figure 1. Locations of sea level stations recording the tsunami. Sea level and hypocentral information (red X) courtesy of the Japan Meteorological Agency.



Tide Station	Arrival Time*	Maximum wave	
		Time*	Height (0-p)
MIYAKO	10/31 10:50	11:33	6 cm
KAMAISHI	10/31 10:47	10:50	6 cm
OFUNATO	10/31 10:43	10:44	22 cm
OSHIKACHO AYUKAWA	10/31 10:43	10:53	32 cm

*local time (JST): UTC + 9:00

Figure 2. Left, Tsunami recorded by stations in Figure 1, with arrival times and heights in the graph to the right. Times given in Japan Standard Time (JST).

RAT ISLANDS, ALEUTIAN ISLANDS, 17 November 2003

Summarized from reports by the West Coast / Alaska Tsunami Warning Center (WC/ATWC, http://wcatwc.arh.noaa.gov/) and Alaska Earthquake Information Center (AEIC, http://www.giseis.alaska.edu/Seis/seis.html)

An earthquake of magnitude Mw 7.8 (HRV) occurred at 06:43 UTC on 17 November 2003, near Amchitka Island (Little Sitkin) in the Rat Islands, Aleutian Islands, Alaska (Figure 1). The earthquake was felt in Shemya, Alaska, 345 km to the west northwest. The Harvard Centroid Moment Tensor Solution indicates thrust faulting (22 km deep) along the Aleutian Trench where the Pacific Plate is being subducted beneath the North American Plate. The earthquake is the largest to occur in North America since the M7.9 Denali Fault, earthquake of 3 November 2002, and the largest in the Aleutian Islands since the M7.9 earthquake in June, 1996. The AEIC located 182 aftershocks in the 17.5 hours after the main shock with the largest aftershock showing a moment magnitude of 5.7. This region is one of the world's most active seismic zones. Over one hundred earthquakes of magnitude seven or larger have occurred along this boundary in the past hundred years.

According to reports by the WC/ATWC (Table 1), the earthquake generated a small tsunami that was recorded locally and across the Pacific in Hawaii, the U.S. West Coast, and Chile. Local tsunami wave heights (peak-to-trough) of 52 cm at Shemya and 20 cm at Adak were measured. In Hawaii, 65 cm and 44 cm high tsunami were observed at Kahului, Maui, and Hilo, Hawaii, respectively. In Chile, a 30 cm high

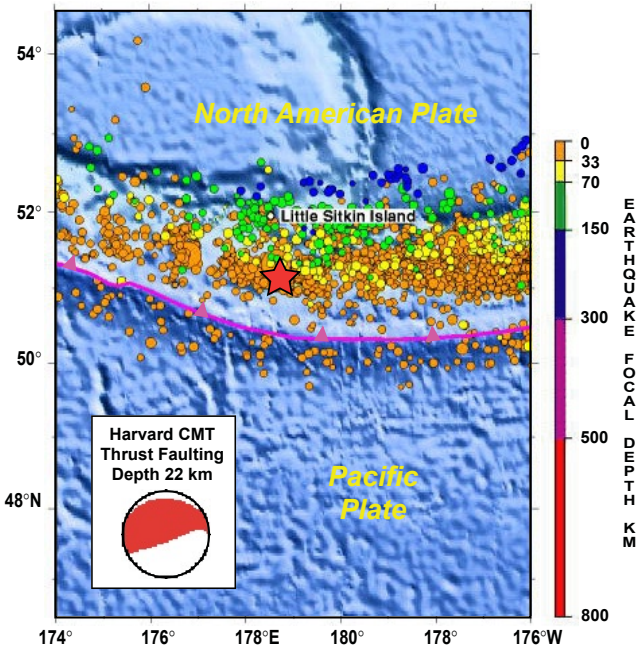


Figure 1. Historical seismicity (1990 to present) from USGS/NEIC. Centroid Moment Tensor solution indicates shallow thrust faulting along a strike parallel to the trench axis.

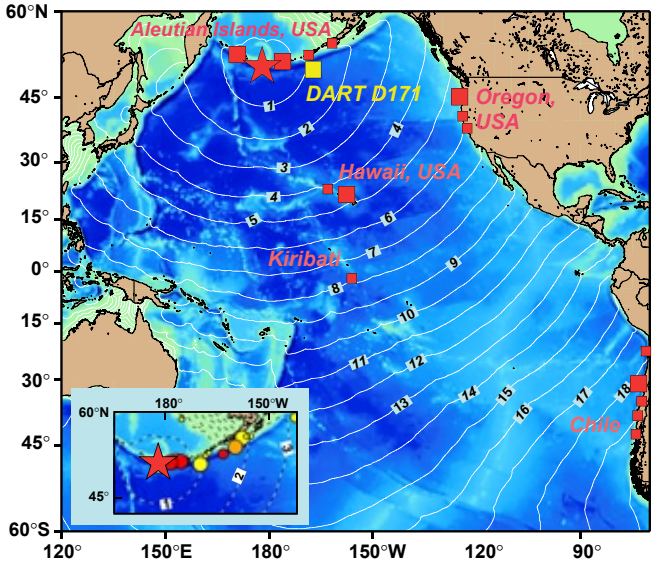


Figure 2. Tsunami travel times for 17 November 2003 earthquake (red star). Contour interval is one hour. Squares show locations of sea level stations listed in Table 1; large squares are stations for which data are shown in Figure 3. Inset shows locations of earthquakes in the source region that generated tsunami; see 25 September 2003 Hokkaido earthquake, Figure 3 for legend.

RAT ISLANDS, ALEUTIAN ISLANDS, *continued*

tsunami was measured at Caldera along the northern coast.

The earthquake was also large enough to trigger the DART D171 tsunameter located to the east. These data were relayed to the WC/ATWC and PTWC, who used the tsunami data as operational decision-making guidance. The small tsunami signal (7 cm peak-to-trough, Table 1) was interpreted to indicate that a Pacific-wide destructive tsunami had not been generated. See also NTHMP and Tsunami "Firsts" meeting summaries in this issue.

Further information and data files for this event can be found at *http://www.prh.noaa.gov/itic/tsunami_events/recent_data/recent_data.html.*

Station Location	Height (cm)	Arrival time UTC)	Sample Interval (min)
Shemya, Alaska, USA	52	0730 11/17	~0.25
Adak, Alaska,	20	0745 11/17	0.33
Sand Point, Alaska	7	0936 11/17	1
DART tsunameter, D171	7	0936 11/17	6
Dutch Harbor, Alaska,	6	? 11/17	0.33
French Frigate Shoals, USA	12	1100 11/17	2
Kawaihae, Hawaii, USA	12	1230 11/17	6
Honolulu, Hawaii	7	1215 11/17	6
Kahului Maui, Hawaii	65	1157 11/17	6
Hilo, Hawaii	44	1200 11/17	6
Nawiliwili, Kauai	18	1135 11/17	6
Charleston, Oregon, USA	10	1300 11/17	6
Port Orford, Oregon	22	1300 11/17	6
North Spit, California, USA	10	1300 11/17	6
Christmas Island, Kiribati	7	1430 11/17	4
Iquique, Chile	8	0112 11/18	2
Caldera, Chile	30	0130 11/18	2
San Antonio, Chile	10	0135 11/18	4
San Pedro, Chile	8	? 11/18	2
Puerto Montt, Chile	8	0600? 11/18	2

Table 1. Tsunami wave heights reported by the WC/ATWC. Heights represent maximum peak-to-trough height in cm. Arrival time is the actual tsunami arrival time on gauges where it could be determined.

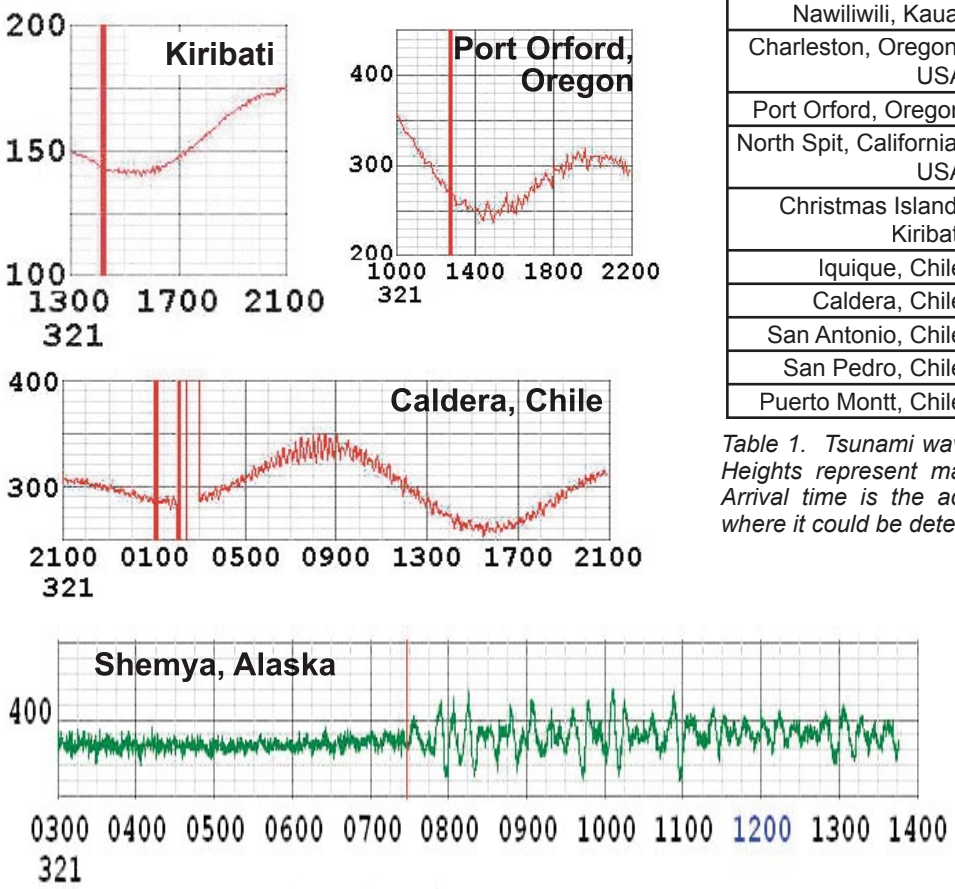


Figure 3. Tsunami recorded at sea-level stations around the Pacific. Data courtesy of NOAA National Ocean Service, the WC/ATWC and PTWC, the University of Hawaii, JMA, and Servicio Hidrográfico y Oceanográfico de la Armada de Chile. Arrivals picked (red vertical line) by the WC/ATWC. Time in Julian Day, UTC.

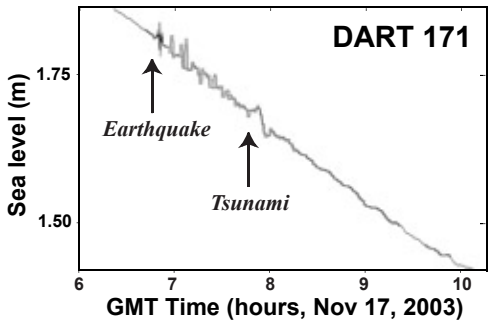


Figure 4. Tsunameter record from the 17 November 2003 earthquake. The D171 DART buoy system was triggered by the passage of the earthquake's seismic waves. Emergency transmissions were telemetered by acoustic modem from the sea bottom to the ocean surface buoy and through the GOES satellite to the warning centers. Data from the NOAA National Data Buoy Center and PTWC.

SOUTHEAST OF LOYALTY ISLANDS, NEW CALEDONIA, 27 December 2003

An earthquake of magnitude Mw 7.3 (HRV) occurred at 16:01 UTC on 27 December 2003, southeast of the Loyalty Islands, and 325 km east of Noumea, New Caledonia. The earthquake was the largest in a series of strong earthquakes that occurred in this complex tectonic region during the last week of December, 2003 and first week of January, 2004. Moment tensor solutions indicate thrust faulting (24 km depth from Harvard) along the New Hebrides Trench where the Indo-Australian plate is being subducted beneath the Pacific plate in the North Fiji Basin.

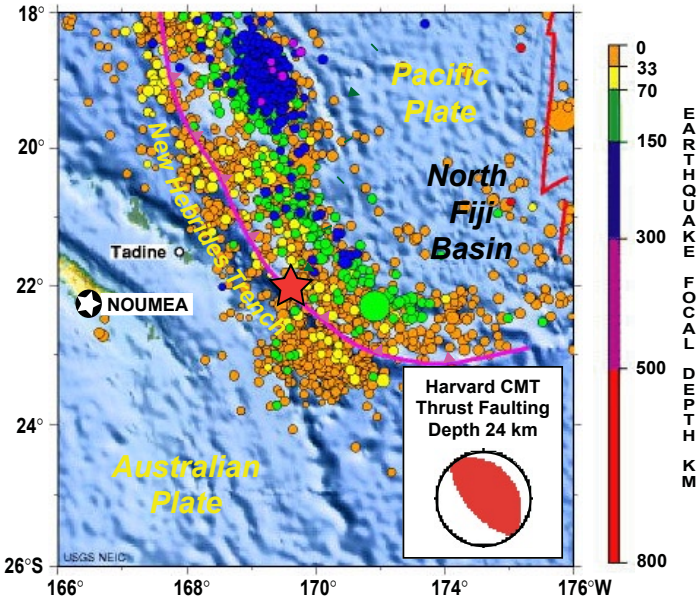


Figure 1. Historical seismicity (1990 to present) from USGS/ NEIC. Harvard Centroid Moment Tensor solution indicates shallow thrust faulting along a strike parallel to the trench axis. Red star shows the location of the earthquake and red squares the locations of sea-level stations that recorded the tsunami.

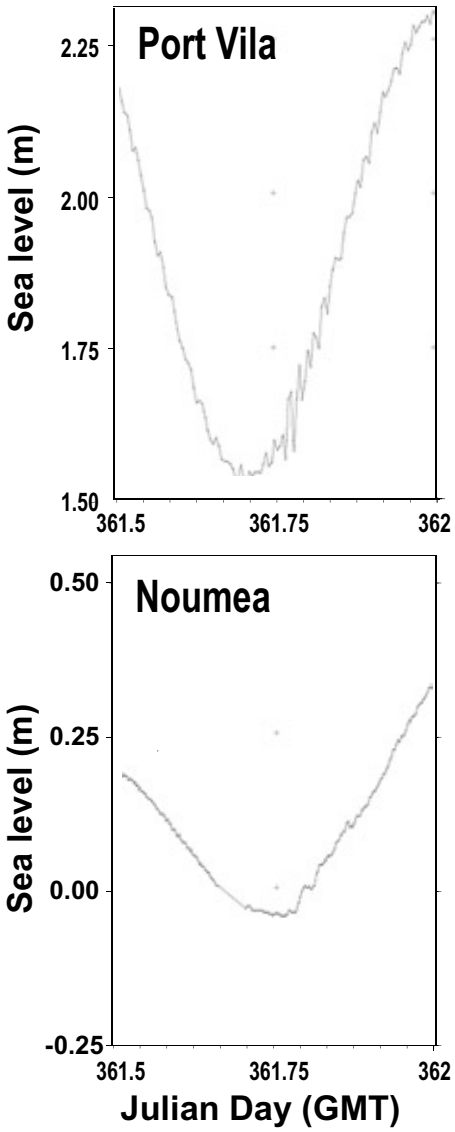


Figure 3. Sea-level data at Port Vila, Vanuatu and Noumea, New Caledonia. Data courtesy of National Tidal Facility, Australia. A 15 cm tsunami (18 minute period) was recorded at Port Vila, Vanuatu. Data sampled at 1 minute intervals.

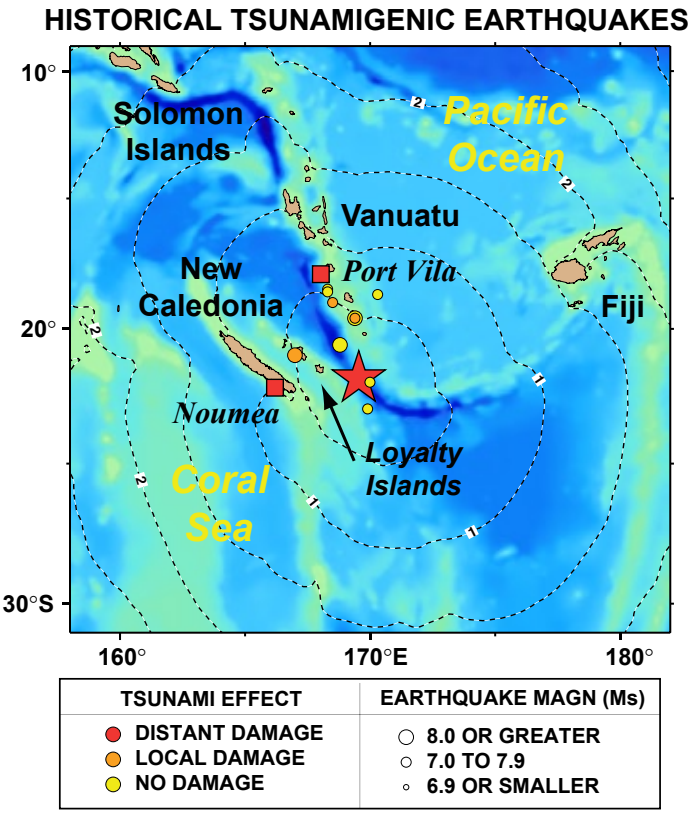


Figure 2. Historical earthquakes that have generated tsunami in this region. Tsunami travel time contours at 0.5 hour intervals.

ITIC NEWS

UNESCO/IOC ITSU TRAINING PROGRAMME 2003

The 2003 ITSU Training Programme (ITP) was held 4-15 August 2003 in Honolulu, Hawaii. This year, the ITIC hosted Mr. Ibnu Purwana, Head, Seismology and Tsunami Division, Badan Meteorologi dan Geofisika/BMG, and also the ITSU National Contact for Indonesia, and Ms. Cecilia Zelaya Gomez from the Sistema Nacional de Alerta de Maremotos (SNAM, National Tsunami Warning Center), Servicio Hidrográfico y Oceanográfico de la Armada de Chile (SHOA). As in other programmes held recently and in response to participants' requests, there was an

Figure 1. PTWC Geophysicist-in-Charge Dr. Chip McCreery (left) shows ITIC Webmaster Tammy Kaitoku (left middle), and ITP participants Zelaya (right middle) and Purwana (right) the Hawaii-area telephone hotline used for emergency broadcasts of tsunami warnings.

increased focus on how to prepare for the local or regional tsunami threat. Specific activities included discussions on the operations of the local tsunami warning system with the Pacific Tsunami Warning Centre (PTWC), (Figures 1 & 2), and visits to the Hawaii State Civil Defense (SCD) and Hawaii County Civil Defense agencies (Figure 3) to discuss the operations of the local emergency management agencies upon receiving a tsunami warning message from PTWC.

In general, ITP participants spend about 40% of their time learning about the international and local tsunami warning systems directly from the PTWC or ITIC, about 30% learning about the local tsunami warning system as carried out by State and County Emergency Agencies, and about 30% in discussions with experts on tsunami hazard assessment and mitigation (inundation mapping and wave forecasting, public education and awareness programmes, and the conduct of post-tsunami surveys). During ITSU-

Figure 2. PTWC Senior Electronics Technician Rich Nygard (center) answers questions about the Makapuu tide gauge station during a site visit.

XIX, the ITIC Director expressed concern that the current ITP (only two weeks in length) allowed the participants to only gain a broad introduction to the many aspects of the tsunami warning system, noting that in-depth treatments and hands-on training have been sacrificed in favour of subject breadth. In response, the ITIC proposed, and Member States agreed, to increase the duration of the ITSU Training Programme to three weeks (15 working days) starting in 2004 (ITP-Hawaii).

Immediately following the ITP Programme, the ITIC Director had the opportunity to visit Indonesia, where she provided tsunami education and warning system and mitigation training to Regional Seismic Center staff, visited their earthquake monitoring facilities, and participated in the Krakatau Seminar/ Workshop in which national participants agreed to make the implementation of a national tsunami warning system a top priority (see workshop article, page 22). These combined activities proved to be a very effective means for intensively focusing on tsunami and information technology transfer. In this case, Mr. Purwana was able to gain experience and information from the PTWC and local civil defence

Figure 3. Zelaya and Purwana (center) also visited the Emergency Operations Center of Hawaii County Civil Defense on the island of Hawaii, where Administrator Troy Kindred (left) and Hawaii County Tsunami Advisor George Curtis (right) briefed them on the County's tsunami response procedures.

officials in Hawaii, which was then followed by the ITIC Director's visit to reinforce those principles learned in Hawaii in his home country. At the same time, the ITIC Director was able to gather information and assess the tsunami mitigation capacity of Indonesia, and discuss with them how ITIC might better serve their needs. Based on this experience, the ITIC Director recommended, and Member States agreed at ITSU-XIX, to establish an international component to the ITSU Training Programme, and further recommended that if possible, the ITP-Hawaii and ITP-International focus on the same country or region in consecutive programmes each year so that the most effective means of technology transfer might be accomplished.

ITP PARTICIPANT REPORTS

INDONESIA

Ibnu Purwana, BMG, Indonesia, ibnu@bmg.go.id

My participation in the ITP 2003 was nominated by the Director General of BMG through a letter no. DL.103/A.2/SB/BMG-03 dated 12 May 2003 in response to IOC Circular Letter no. 2066 dated 9 April 2003 on UNESCO/IOC ICG/ITSU Training Program 2003. This was approved by the IOC on 16 June 2003 and further acknowledged by the Director of International Tsunami Information Center (ITIC) on 20 June 2003. In my position as the Head of Seismology and Tsunami Division of BMG and ITSU National Contact of Indonesia, my special interests to the training program materials are those related to Standard Operation Procedures for Earthquake Monitoring and Tsunami Warning.

The trip and programs of the ITP 2003 were conducted on schedule as written on the Detailed Agenda and Topics Covered provided by ITIC. From these, I summarize important points as follows:

1. *Becoming familiar with the ITIC Library and use of the Expert Historical Tsunami Database Program, 2002,*
2. *Learning about quick hypocenter and magnitude determination (M_{wp}) at PTWC (Figure 4),*

Figure 4. In the PTWC Operations Center, from left to right, Geophysicist Barry Hirshorn, Purwana, Zelaya, GIC Dr. Chip McCreery, and Geophysicist Dr. Stuart Weinstein.

3. *Learning about tsunami warning system needs and requirements,*
4. *Learning about sea level and run-up monitoring (including test message transmission from an artificial run-up occurrence),*
5. *Learning about the standard operating procedures for distant and locally-generated tsunami by the Hawaii State Civil Defense (Figure 5) and Hawaii County Civil Defense agencies,*
6. *Learning about the standard operating procedures for the issuance of local and distant tsunami warning by PTWC,*
7. *Learning about volcanic monitoring at the USGS Hawaiian Volcano Observatory, (Figure 6)*
8. *Learning about the importance of the Pacific Museum, memorials and monuments,*
9. *Learning about tsunami propagation modeling and inundation mapping at University of Hawaii*.

Figure 5. During a visit to the Hawaii State Civil Defense (SCD) Emergency Operations Center, Gaye Downes (New Zealand, left) asks Brian Yanagi (SCD Tsunami Programme Manager, right) questions about the Hawaii Regional Tsunami Warning System while Zelaya and Purwana look on.

CHILE

Cecilia Zelaya, SNAM, SHOA, Chile, czelaya@shoa.cl

From August 4, to August 15, 2003, the International Tsunami Training Programme was held in Honolulu, Hawaii, USA under the direction of Dr. Laura Kong, ITIC Director. The purpose of the program was to show the experts-in-training the new techniques and procedures used by the Pacific Tsunami Warning System and to learn about the advances of the international programmes in the field of the tsunami risk mitigation. The agenda of the training program was divided in two parts. The theoretical part included general concepts about earthquakes and tsunamis, evaluation of the tsunamigenic potential of an earthquake, International and Local Tsunami Warning

ITP REPORTS, *continued*

Systems with their respective procedures and methodologies, tsunami inundation maps, tsunami risk mitigation and some general ideas about geology and volcanic seismology. The practical part included visits to the different Emergency Operations Centers like the Pacific Tsunami Warning Center (PTWC), the local Civil Defense agencies, seismic stations and tide gauges, the USGS Hawaiian Volcano Observatory, the Pacific Tsunami Museum and historical places on the island of Hawaii where tsunamis were recorded.

Many concepts and ideas regarding the training were made clear to me. I learned a lot about the present methodologies and procedures applied by the operating centers in handling emergencies, and was able to compare and note differences in them with the existing methodologies and procedures used at the Chilean TWS (SNAM). Also, much was learned about the usefulness of historical local and distant earthquake and tsunami data for tsunami warning, and about the existing internal and external data and message communications. Other important topics included how to measure the efficiency of the system to deliver watches and warnings, how to identify future needs and the necessary resources for new technologies to be used at SNAM, and more knowledge regarding the use of seismic magnitudes and their relationship with the seismic moment. Another very interesting experience for me was to meet the experts and learn about the work done in numerical modeling and the use of sea level data in real time for tsunami forecasting.

With the knowledge acquired, I plan to improve SNAM's technical and operative capabilities. Projects will include the development of new tools for the decision-making process, continuing efforts in tsunami mitigation focused on the student population, and proposals to improve numerical modeling, such as training to work with the new algorithms and local information to implement a tsunami impact forecasting method for coastal communities.

Figure 6. At the USGS Hawaiian Volcano Observatory, Dr. Paul Okubo (left) briefed Purwana and Zelaya (right) on the real-time seismic monitoring of the active Kilauea Volcano and gave them a tour of the Uwekahuna seismic vault.

GLOBAL TSUNAMI DATABASE PROJECT (GTDB)

Paula Dunbar, Tsunami Programme Manager, NOAA/NESDIS National Geophysical Data Center (NGDC), 325, Broadway, Boulder, Colorado 80305-6084 USA, and World Data Center for Solid Earth Geophysics (WDC-SGE), paula.dunbar@noaa.gov, and
Viacheslav Gusiakov, Head, Tsunami Laboratory, Institute of Computational Mathematics & Mathlogical Geophysics (NTL/ICMMG), Lavrentieva, 6, Novosibirsk 630090, Russian Federation, gvk@sscc.ru.

Earlier this year, the ITIC (Honolulu), the WDC-SEG/NGDC (Boulder) and the NTL/ICMMG (Novosibirsk) collaborated on the development of a plan to compile a unified and comprehensive Global Tsunami Database (GTDB) by merging the two existing tsunami databases currently maintained separately by the WDC/NGDC and the NTL/ICMMG. The first draft of the proposal was developed in June of 2003 during the preparation of the first working meeting on the GTDB Project held on 8 July 2003 in Sapporo, Japan, prior to the IUGG Tsunami Symposium (*Tsunami Newsletter*, June 2003). A general plan of action was discussed at this meeting, including the need for a new database format and a working visit by V. Gusiakov (NTL/ICMMG) to the WDC/NGDC in summer 2004 to merge the databases. The second meeting was held in Wellington, New Zealand just before the beginning of the International Tsunami Workshop and the XIXth ICG/ITSU Session. This meeting was attended by P. Dunbar (WDC/NGDC), V. Gusiakov (NTL/ICMMG), C. McCreery (PTWC Director), K. Satake (IUGG/TC Chair), N. Nishide (JMA, Japan), N. Puspito (ITB, Indonesia), and P. Wood (IGNS Ltd., New Zealand). The new database format was presented, which includes additional fields for run-up references and numbers of casualties and injuries. After intensive discussion, it was agreed that some of the format details will be resolved during V. Gusiakov's working visit to WDC/NGDC. The need and procedure for obtaining input from the HTDB Regional Coordinators was also discussed. It was also agreed that there is a need to convene a Regional Coordinators meeting in late 2004 or early 2005 to discuss the new procedures for future maintenance and improvement of the GTDB.

The detailed proposal on the GTDB Project was presented to the ITSU-XIX (under Agenda Item 7.3), and received positive support from the Member States. The resulting recommendation (ITSU-XIX.3 Recommendation) encourages the project participants (ITIC, WDC/NGDC, and NTL/ICMMG) to implement the GTDB Project in 2003-2005, with financial support to be provided jointly by the U. S. National Weather Service / Pacific Region (NWS/PR) and the IOC. The official copy of the database will be housed and maintained at the WDC/NGDC using the

GTDB, *continued*

Oracle RDBMS software; from here, the data can be accessed via Web-based HTML forms and ArcIMS interactive maps, as well as exported in different formats specified by the ITIC for the use of the tsunami warning centers and other potential users.

The offline, stand-alone application (WinHTDB graphic shell) will continue to be supported, and updated by adding a new software calculation for Tsunami Travel Times (TTT), with funding from the NWS/PR. Support for this application is deemed essential because some users may not have easy access to the Internet, as well as have a need to access the historical data in an "offline" mode. Upon completion of the first phase of the project in late 2004, the WDC/NGDC will provide 100 copies of a CD-ROM containing the database, graphic shell, and TTT software to the IOC Secretariat for distribution to the Member States.

JAPAN GOVERNMENT TEAM VISITS HAWAII

A joint research team consisting of officials from the Cabinet Office (CAO), the Fire and Disaster Management Agency (FDMA), the Japan Meteorological Agency (JMA), and the Japan Weather Association (JWA) visited Hawaii from November 22 to 26, 2003, to learn about the Hawaii Regional Tsunami Warning System (HRTWS) (Figure 1). Collectively, these Japanese agencies are

Figure 1. The Japan Joint Research Team was briefed on the activities of the USA National Tsunami Hazard Mitigation Program by NTHMP Chair and US Tsunami Programmer Manager Jeff LaDouce. From left to right, row 1: Tatsuo Kuwayama, Chief for Tsunamis, JMA; Nobuaki Kon, Director for Earthquakes and Volcanoes, CAO, and Team Leader; Hiroaki Miyatake, Assistant Director, CAO. In row 2, Yoshiki Yamazaki, Interpreter and Graduate Student, University of Hawaii at Manoa; Kouji Aizawa, Technical Official for Planning, JMA; Tatsushi Ueda, Deputy Director for Earthquakes, FDMA; Jeff LaDouce; Motohiro Honma, Technical Official for Meteorology, JWA; Masafumi Hosokawa, Assistant Director for Information, FDMA.

JAPAN VISIT, *continued*

responsible for the preparation of tsunami advisories and alarms, as well as the dissemination of timely and useful warnings to local residents that permit them to easily evacuate before the arrival of the tsunami waves. The Joint Research Team was formed after the 25 September 2003 Hokkaido earthquake and tsunami, to identify improvements that can be made in Japan's Tsunami Warning System to more effectively

Figure 2. PTWC GIC Dr. Chip McCreery demonstrated PTWC's earthquake evaluation software during a tour of the operations center. From left to right, Miyatake, Kon, Aizawa, Kuwayama, and McCreery.

prepare informational products for the relevant authorities and the public, and ways in which to raise public awareness on tsunami hazards and warning responses critical to reduce risks from local tsunami sources. The purpose of their visit was to collect information on the tsunami information systems currently used in emergency operations in Hawaii, especially those communication tools employed during the occurrence of locally-generated tsunamis around Hawaii, and to interview and exchange opinions with experts from the responsible agencies.

While in Hawaii, they visited the Pacific Tsunami Museum in Hilo, Hawaii, where Director Donna Saiki gave them a tour of their comprehensive exhibits on the tsunamis that have devastated Hawaii; the Richard H. Hagemeyer Pacific Tsunami Warning Center (PTWC) in Ewa Beach, Oahu, where Geophysicist-in-Charge (GIC) Dr. Chip McCreery briefed them on the seismic and tsunami detection and evaluation techniques, and the warning message dissemination protocols used by the PTWC for the HRTWS (Figure 2); the International Tsunami Information Center (ITIC), where Director Laura Kong provided information on additional integrated tsunami warning tools used by the PTWC and the Hawaii State Civil Defense, and ITIC Technical Information Specialist Linda Sjogren provided a tour of the ITIC library; the National Weather Service Pacific Region Headquarters where Director Jeff LaDouce briefed them on the U.S. National Tsunami Hazard Mitigation Program (NTHMP), and NOAA Public Affairs Officer Delores Clark gave them information on NOAA's tsunami outreach and education activities; and the Hawaii State Civil Defense Emergency Operations Center (SCD EOC), where SCD Tsunami and Earthquake Program Manager Brian Yanagi briefed

JAPAN VISIT, *continued*

them on the State's responses to PTWC-issued tsunami warnings and other mitigation efforts, and Oahu Civil Defense Public Affairs Officer John Cummings, III, answered questions on the County's tsunami warning responses and its role in organizing evacuations of the coastlines.

Figure 3. Oahu Civil Defense Public Affairs Officer John Cummings, III, explained the tsunami evacuation procedures for Honolulu during a meeting at SCD EOC. From left to right, Yamazaki, Miyatake, Honma, Ueda and Aizawa with backs to camera, and facing Kon, Kuwayama, Hosokawa, and Cummings.

KOREA METEOROLOGICAL ADMINISTRATION VISITS HAWAII

Duk Kee Lee, Marine Meteorology & Earthquake Research Laboratory, dukkee@metri.re.kr, and Jun Hee Lee, Earthquake Division, ljh@kma.go.kr, Korea Meteorological Administration (KMA), 460-18, Sindaebang-dong, Dongjak-gu, Seoul 156-720, Korea

As part of the bilateral cooperation in meteorology between the U. S. National Weather Service and the Republic of Korea, the PTWC and ITIC hosted staff from the Korea Meteorological Administration (KMA) during their visit from 30 November to 7 December 2003. While here, Dr. Duk Kee Lee and Mr. Jun Hee Lee visited the PTWC where Geophysicist-in-Charge Dr. Charles "Chip" McCreery introduced them to the operations of the Tsunami Warning System in the Pacific and Hawaii Regional Tsunami Warning System operations. The scientists also visited the ITIC where Director Dr. Laura Kong and briefed them on how tsunami warnings are integrated into the emergency response activities of the Hawaii State Civil Defense, and Technical Information Specialist Linda Sjogren provided them with tsunami safety and other mitigation materials. The visits were very useful as KMA is developing its own national tsunami observation system. KMA staff were briefed on the various components of PTWC's seismic observing systems and about existing and new tsunami-detecting technologies, and were able to discuss with PTWC possibilities for data exchange

KMA VISIT, *continued*

between the two countries. Upon returning, the KMA began several education projects aimed at providing more information on tsunamis to the public. Using electronic materials provided by the ITIC, the KMA is translating the Tsunami Glossary and other ITIC awareness materials into Korean, and plans to use these materials as the basis for developing its own national tsunami training programs.

From left to right, Jun Hee Lee, Dr. Laura Kong and Dr. Duk Kee Lee in front of the ITIC office.

NEW TSUNAMI BULLETIN BOARD IMPLEMENTED

In December, 2003, the ITIC debuted its new Tsunami Bulletin Board (TBB) software to members after a six month research and development period brought on by a computer failure and several system security breaches. Originally begun by NOAA's PMEL and transferred to the ITIC in 1995, the TBB list serve provides an open, objective scientific forum for the posting and discussion of news relating to tsunamis and tsunami research by researchers and other technical professionals. The ITIC is offering this service to facilitate the widespread and timely dissemination of information on tsunami events, current research investigations, and announcements for upcoming meetings, publications, and other tsunami-related materials. All members of the TBB are welcome to contribute. Messages are immediately broadcast to all members without modification. The TBB is available both as a regular email service and through the Web. Members also automatically and immediately receive the tsunami bulletins issued by the PTWC and WC/ATWC. The list serve utilizes the U.S. National Weather Service's Infolist service. Currently, there are over 200 international members. For more information, or to subscribe to the TBB list serve, please contact us at *itic.tsunami@noaa.gov*.

ITSU NEWS

ITSU XIX

Nineteenth Session of the International Co-ordination Group for the Tsunami Warning System in the Pacific

Wellington, New Zealand, 29 September – 2 October 2003

The Nineteenth Session of the International Coordination Group for the Tsunami Warning System in the Pacific was held in Wellington, New Zealand, from 29 September to 3 October 2003 under the Chairmanship of Dr. François Schindelé (Figure 1). It was attended by 34 participants from 15 Member States and two organizations and hosted by New Zealand (Figure 2). The Session reviewed progress made during the inter-sessional period 2001-2003 and drafted its work plan for the period 2004-2005. This work plan will focus on (i) continued support for the International Tsunami Information Centre (ITIC); (ii) support for the development of the Global Tsunami Data Base (GTDB) and the new Integrated Tsunami Data Base (ITDB) consisting of the WinHTDB graphic shell and a Tsunami Travel Time (TTT) module; (iii) finalization of the Tsunami Information Kit; (iv) support for the newly established Working Group on a Comprehensive Tsunami Hazard Reduction Programme (TROIKA); (v) support for the newly established Working Group on the Central American Pacific Coast Tsunami Warning System (CAPC-TWS) (Figure 3); and (vi) support for the newly established Working Group on the Tsunami Warning System in the Southwest Pacific and Indian Ocean (SWP-TWS).

Figure 1. The ITSU Officers, in coordination with the IOC, provided excellent leadership during the last Intersessional Period, and were re-elected by Member States to serve a third and final term. From left to right, Dimitri Travin (IOC Ocean Services), Dr. Chip McCreery (ITSU Vice-Chairman), Dr. François Schindelé (ITSU Chair), and Peter Pissierssens (Head, IOC Ocean Services and Tsunami Programme Technical Secretary).

The Group requested a budget of USD$141,500 for the biennium 2004-2005 to accomplish the work plan. The Group further decided to (i) study possibilities for cooperation with JCOMM; (ii) increase the duration of its ITSU Training Programme held in Hawaii (ITP-Hawaii) to three weeks, and establish an international component (ITP-International) for in-country assistance to Member States; (iii) establish a "Pool of Experts" to assist Member States with expert missions; (iv) accept the "Tsunami Hazard Zone" and "Tsunami Evacuation Route" signs and submit these to ISO; (v) recommend formal collaborative links with the Circum-Pacific Council; (vi) reduce the frequency of the Tsunami Newsletter to four issues per year; (vii) redefine the terms of reference of the IOC-ITSU and ITIC web sites; and (viii) recommend close collaboration with ISDR and with CEPREDENAC.

Figure 2. ITSU-XIX went smoothly thanks to the tireless efforts of the Local Support Team (from left, James O'Reilly, Jessica Smith, and Sara Williams), Mike O'Leary (ITSU New Zealand National Contact and Local Organizer), and longtime ITSU Administrative Assistant Adrien Vannier (IOC Ocean Services).

Two Pacific countries, El Salvador and Papua New Guinea attended ITSU-XIX as observer organizations interested in joining ITSU. In September, 2003, El Salvador formally requested membership to ITSU in a letter to IOC Executive Secretary Dr. Patricio Bernal; and has since become the 26th ITSU Member State. During the meeting, the representative of Papua New Guinea reported that it would be requesting membership to the IOC and then to ITSU.

The Group further revised the ITSU Master Plan's conclusions, adding focus on the acquisition of data in real-time and optimizing the network to ensure accurate warning issuance and minimization of false warnings (Figure 4). The Group requested to urgently

ITSU-XIX, *continued*

proceed with the Review of the ITSU Programme in 2004. The Group also re-elected Dr. François Schindelé and Dr. Charles McCreery as ITSU Chair and Vice-Chair, respectively, and welcomed Mr. Emilio Lorca as the new ITIC Associate Director to replace Commander Rodrigo Nuñez.

The Summary Report, as well as the Session's Provisional Documents, National Reports and other related information can be accessed from the ITSU Web Site at *http://ioc.unesco.org/itsu*.

During the meeting, a reception at the Parliament was hosted and addressed by the New Zealand Minister of Civil Defence, the Honorable George Hawkins, and sponsored by UNESCO New Zealand (Figure 5). The Chair of the National Committee for IGCP, UNESCO NZ, Vince Neal, Associate Professor of Soil and Earth Sciences, Massey University, also addressed the delegates. Following the reception, NZ National Readiness Manager and ITSU National Contact, Mike O'Leary, led a tour of the National Crisis Management Centre located beneath the Parliament.

Figure 3. From left to right, Mr. Claudio Guitierrez Huete (Executive Director, Nicaragua Institute for Territorial Studies, INETER and ITSU National Contact) and Mr. Carlos Pullinger (Director, Servicio Geologico, Servicio Nacional de Estudios Territoriales, El Slavador) discuss the proposed Central America Pacific Coast Tsunami Warning System.

Figure 4. Delegates reviewed and discussed progress during the Intersessional period. From left to right, Prof. Hansjürgen Meyer (Universidad del Valle Observatorio Sismológico del Suroccidente – OSSO, Colombia), Capt. Fernando Mingram (Director) and Mr. Emilio Lorca (incoming ITIC Associate Director, both from Servicio Hidrográfico y Oceanográfico de la Armada de Chile), and Mr. Fred Stephenson (Manager, Geomatics Engineering, Canadian Hydrographic Service, Institute of Ocean Services).

Figure 5. At the reception, from left to right, Mr. Duck-Mo Woo (Director, Earthquake Div., Climate Bureau Korea Meteorological Administration), Mr. Noritake Nishide (Director, Earthquake & Tsunami Observation Division, Seismological & Volcanological Dept., Japan Meteorological Agency), and Dr. Laura Kong (ITIC Director).

Figure 6. Fromt left to right, Mr. Lawrence Anton (Chief Seismologist, Papua New Guinea Geological Survey) and Mr. Lasarusa Vuetibau (Senior Seismologist, Fiji Mineral Resources Department) discuss the seismic hazards of the south Pacific.

EL SALVADOR JOINS ITSU

In September, 2003, El Salvador requested membership to the ICG/ITSU, and in November, 2003, Ing. Walter E. Jokisch, Minister of the "Ministerio de Medio Ambiente y Recursos Naturales" nominated Mr. Antonio Arenas, Director General of the "Servicio de Estudios Territoriales" (SNET) to be its National Contact. El Salvador becomes the 26th Member State of the ICG/ITSU.

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CHILE DEPLOYS TSUNAMETER

Emilio Lorca Mella, Geologo, Jefe Seccion Geofisica Marina, Departamento de Oceanografia, SHOA, elorca@shoa.cl

On November 23, 2003, the Servicio Hidrográfico y Oceanográfico de la Armada de Chile (SHOA) deployed a new deep-ocean tsunami detecting system off the northern coast of Chile at 19° 40.31`S, 74° 50.29` W, at a water depth of 4,960 meters. The system was developed by the United States' NOAA/Pacific Marine Environmental Laboratory (PMEL) and is identical to six other DART (Deep-ocean Assessment and Reporting of Tsunamis) buoys currently deployed in the north and equatorial Pacific (Figure 1). The Chile tsunameter is the first early warning tsunami buoy deployed in the southeastern Pacific (Figure 2).

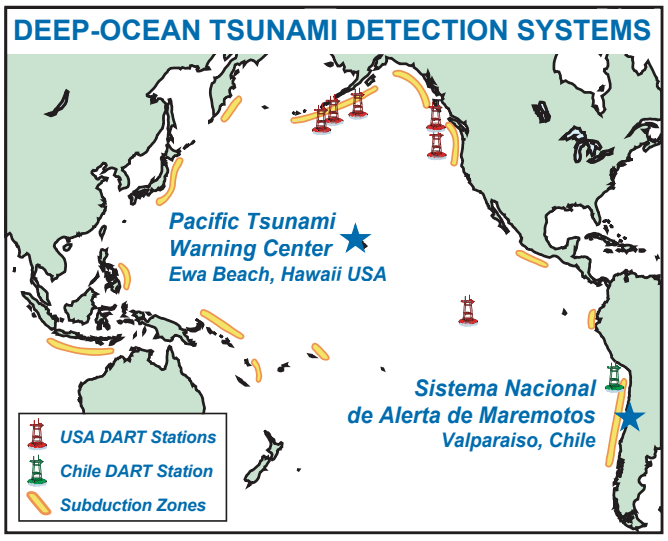


Figure 1. Current DART Network.

The buoy is part of Chile`s Sistema Nacional de Alerta de Maremotos (National Tsunami Warning System) and will enhance the warning capabilities within the region. Tsunami transmissions will also be received in real-time by the PTWC for use in the Pacific Tsunami Warning System. The deployment was performed, using the R/V Roger Revelle from Scripps Institution of Oceanography, by an international team from Chile (SHOA) and the USA (PMEL, National Data Buoy Center, NDBC), (Figure 3).

Figure 2. SHOA DART buoy being hoisted prior to deployment.

Figure 3. DART buoy deployment team. Scott Stalin (PMEL), Michael Strick (PMEL), Kendal Michel (NDBC), Juan Andueza (SHOA), Alvaro Vera (SHOA), Juan Belmar (SHOA), and Cecilia Zelaya (SHOA, not shown as she was taking picture).

TSUNAMI PROGRAMME TRUST FUND

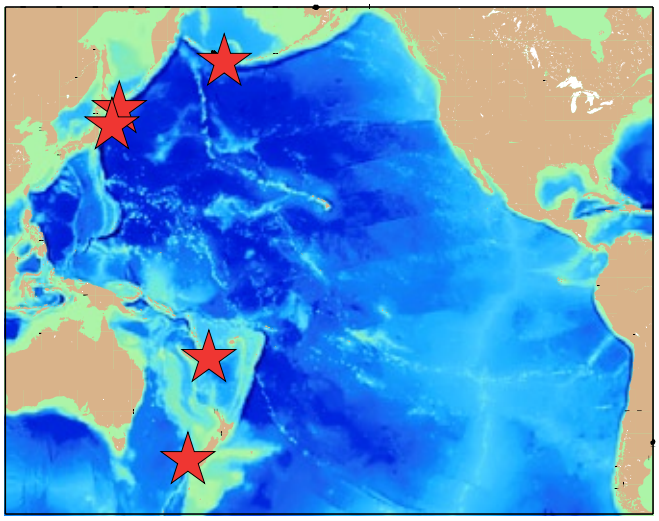
During 2003, in support of the ITSU Programme, a total of USD $24,100.74 was contributed to the IOC Tsunami Programme Trust Fund. These included USD $10600.74 from France, $5000 from New Zealand, $3000 from Chile, $2000 from Peru, $1000 from the Republic of Korea, and $2500 from World Book Publishing. World Book made the donation after receiving an article written by ITIC Director Dr. Laura Kong. The article, *Big Waves: Tracking Deadly Tsunamis*, was published in the 2004 Science Year published by World Book, and can be downloaded at *http://www.prh.noaa.gov/itic/library/about_tsu/overviews.html*.

Contributions by Member States to the IOC Trust Fund, earmarked for ITSU, as well as other financial or in-kind support, continue to be essential to cover the difference between the amount received from the UNESCO Regular Programme and that approved as the ITSU Programme budget at each biennial meeting. In 2004, the UNESCO Regular Programme will contribute USD $43,750 towards the ITSU Programme budget of USD $63,000. Additionally, the USA continues to host the ITIC and in 2004 will fund the GTDB Project, which will merge the existing HTDB and NGDC databases into a single, high-quality historical tsunami database, as well as the development of a tsunami travel time calculation and display tool for the stand-alone Expert Tsunami Database application. Chile continues to provide in-kind support for the ITIC Associate Director and will print the Spanish and English versions of the Tsunami Glossary in 2004.

ITIC TSUNAMI EVENT DATA PORTAL

Information and data, including mareograms and travel time maps, compiled by the ITIC and other organizations on recent events can be found at *http://www.prh.noaa.gov/itic/tsunami_events/recent_data/recent_data.html.*

The ITIC continues to serve the tsunami community by acting as a clearinghouse for the collection of seismic, sea level and tsunami damage report data after a tsunami event. Member States are encouraged to help in this effort by sending these data to the ITIC for archiving.



Recent earthquakes for which tsunami event data are available through the portal.

WORKSHOP AND MEETING SUMMARIES

INTERNATIONAL SEMINAR/WORKSHOP ON TSUNAMI: "IN MEMORIAM 120 YEARS OF KRAKATAU ERUPTION – TSUNAMI AND LESSON LEARNED FROM LARGE TSUNAMI"

Jakarta – Anyer, Indonesia, 26 – 29 August 2003

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Fauzi, Coordinator, Earthquake Analysis and Information Services, fauzi@bmg.go.id
Both at: Indonesia Meteorological & Geophysical Agency, JL. Angkasa J / No. 2. P.O. Box 3540 Jakarta 10720 Indonesia

Following the recommendation of the Eighteenth Session of International Coordination Group for the Tsunami Warning System in the Pacific (ITSU-XVIII) 2001 to remember the great eruption of Krakatau 120 years ago, on 27 August 1883, and increase the awareness of people in tsunami- and earthquake-prone areas of the potential for future tsunamis, the Indonesia Meteorological and Geophysical Agency (Badan Meteorologi dan Geofisika, or BMG) and Department of Marine Affairs and Fishery (Departemen Kelautan dan Perikanan, DKP) organised a seminar and workshop in Indonesia during August, 2003.

The opening session of the seminar/workshop was held in Jakarta on 26 August and continued on 27-28 August in Anyer-Banten, a seaside town located close to the Krakatau volcano. On 29 August, a boat trip to view the Krakatau complex was organised to conclude the workshop. The event was conducted in cooperation with the UNESCO/IOC ITSU, the IUGG – Tsunami Commission, and several related government institutions in Indonesia.

KRAKATAU, *continued*

Figure 1. Earthquake and tsunami monitoring activities are the responsibility of the Indonesia Meteorological and Geophysical Agency (BMG), who organized the seminar/workshop in cooperation with the Department of Marine Affairs and Fishery. Shown from left to right are Ibnu Purwana (BMG Seismology and Tsunami Division Head), Hery Harjanto (BMG Deputy Director General for Observation), Dr. Laura Kong (ITIC Director), Sunarjo (BMG Director of Center for Geophysics), and Dr. Viacheslav Gusiakov (outgoing IUGG Tsunami Commission Chair).

The objectives of the seminar and workshop were to:

1. *Strengthen links among key agencies responsible for earthquake and tsunami monitoring, and disaster management in their countries;*
2. *Share experiences and expertise on tsunami disaster management;*
3. *Introduce the Indonesian government to the links between earthquakes in general, and tsunami hazards specifically, and their national plan;*
4. *Evaluate the progress of tsunami monitoring systems in each country;*
5. *Evaluate the knowledge of the people in earthquake- and tsunami-prone areas to the disaster; and*
6. *Initiate the establishment of a tsunami warning system in the Indian Ocean and Southwest Pacific.*

Presentations were made by international tsunami scientists and seismologists, local government authorities from provinces and municipalities who had experienced and responded to recent tsunami and earthquake disasters, and Indonesian institutional stakeholders with missions to monitor and manage the disasters, who presented the current status of their technology, policies and procedures, and their programs for the future. All of the information presented during the workshop was discussed at the end to formulate meeting recommendations. On the first day, three ministers of the Republic of Indonesia gave opening speeches. The workshop was opened by Mr. Yusuf Kalla, Coordinating Minister for People Welfare, and was followed by keynote speeches from the Minister for Marine Affairs and Fishery, and the Minister for Communication. Following the formal welcomes, Dr. L. Kong, ITIC Director, gave a presentation on the Hawaii Regional Tsunami Warning System and its integration with local civil defense authorities, and Dr. V. Gusiakov, Outgoing Chair, IUGG Tsunami Commission, gave a presentation on the Historical Tsunami Database for the Pacific. In total, 120 scientists, engineers, researchers, and public officials representing seismologists, geologists, oceanographers, coastal engineers, emergency managers, university lecturers, and local government officers participated in the meeting. The participants came from throughout Indonesia and internationally from the USA, Russia, Germany, Japan and the Netherlands. Altogether, six presentations were made on the first day, ten on the second day, and six on the third day. Following the presentations on the third day, about three hours were spent discussing and formulating the seminar/workshop recommendations. The discussions involved all stakeholders involved in natural disaster management, with special attention focused on the development of a tsunami early warning system in Indonesia.

Recommendations

The workshop concluded with five recommendations:

I. Increase tsunami hazard and risk awareness of people:
   - *Recommends the construction of community memorials, such as monuments, museums, and informational signage, to remind each other and provide a means of passing tsunami information to next generation.*
   - *Further recommends the preparation and publication of informational leaflets, pamphlets, and books for the public*

Figure 2. In Anyer on Days 2 and 3, workshop participants listened to presentations by local officials on their experiences in recent natural hazard disasters.

KRAKATAU, *continued*

and at-risk communities, and the dissemination of these appropriately in partnership with the mass media so as to increase society's awareness of and preparation for this natural hazard.

Figure 3. On Day 4, Dr. Igan S. Sutawidjaja,right, (Directorate of Volcanology and Geological Hazard Mitigation), led a field trip to view the Krakatau volcanic complex. Shown in the background is the 200 m high Anak Krakatau (child of Krakatau), which first erupted in 1927 along the north wall of the remaining caldera rim, and last erupted in 1996.

II. Establish a Tsunami Warning System:
- *Recommends the establishment of a National Tsunami Warning System based on existing national seismic and sea level networks, real-time telemetry and automated data processing and evaluation, and reliable methods of warning dissemination, taking into account the experience resulting from the operation of existing regional and national tsunami warning systems in the Pacific. This System should be designed so as to permit the future expansion of its area of responsibility to provide services to other parts of the Southwest Pacific and Indian Ocean.*

III. Establish guidelines to face and anticipate tsunami disasters:
- *Strongly urges the local government to implement countermeasures for protection against tsunami in the form of green belts, and sea walls or other concrete constructions, to reduce the impacts of tsunami.*
- *Recommends the preparation of guidelines for disaster management in coastal areas.*

IV. Construct Historical Tsunami Database:
- *Recommends that a comprehensive historical tsunami database be created in a format compatible with internationally-approved standards.*

V. Prepare Coastal Evacuation Maps:
- *Recommends the undertaking of efforts to carry out tsunami inundation modeling studies and the preparation of evacuation maps for all populated coastal areas threatened by local tsunamis, and to educate those at-risk populations about local tsunamis, the dangers they pose, and the steps they must take to protect their lives should one occur.*
- *Further recommends the preparation of multi-hazard, micro- and macro-zonation maps which include the distribution of occurrences and potential impacts of all natural hazards in selected at-risk areas.*

In March, 2004, the BMG reported that the recommendation to implement a National Tsunami Warning System for Indonesia was approved. The BMG and the Mapping Agency of Indonesia are currently preparing a Memorandum of Understanding for the utilization of tide gauges operated by Mapping Agency. These real-time data will be combined with broadband seismograph data to monitor the seismicity and occurrence of tsunami.

Figure 4. The tsunami from the 1883 Krakatau eruption generated runups of more than 30 m, killing more than 36,000 people and depositing huge boulders along the coasts of the islands of Java and Sumatra. Shown is the largest deposit, a coral boulder 10 m by 7 m wide and 3.5 m high with an estimated volume of 240 m^3 and weighing 600 tons, located about 100 m inland. During the meeting, Dr. Hamzah Latief (Head, Coastal Oceanography Laboratory, Institute of Technology, Bandung) and his students provided a short tour around Anyer to examine the deposits. From left to right are Dr. Latief, Dr. Gusiakov, students, Anouk Ratna Suminar and Azalea Hidayat, Dr. Yuichi Nishimura (Hokkaido University), and student Aditya Riadi Gusman.

INTERNATIONAL WORKSHOP: TSUNAMIS IN THE SOUTH PACIFIC-RESEARCH TOWARDS PREPAREDNESS AND MITIGATION

Wellington, New Zealand, 25-26 September 2003

Eighty-six participants from 18 countries attended the Workshop, which was jointly organized and convened by the IUGG Tsunami Commission (Dr. Viacheslav Gusiakov, Russia) and the ICG/ITSU (Dr. François Schindelé), the New Zealand Institute of Geological & Nuclear Sciences (GNS, Gaye Downes) and the New Zealand National Institute for Water and Atmospheric Research (NIWA, Dr. Roy Walters). Thirty-one papers were presented orally, ranging from overviews of regional vulnerability to tsunami, the Pacific historical tsunami record, Pacific-wide and regional tsunami warning systems, and preparedness plans, as well as insights into public awareness and preparedness in New Zealand and Washington, USA, tsunami modeling, paleo-tsunami research in New Zealand and submarine landslide identification and tsunami generation potential. Eight posters were also presented. A presentation was given by

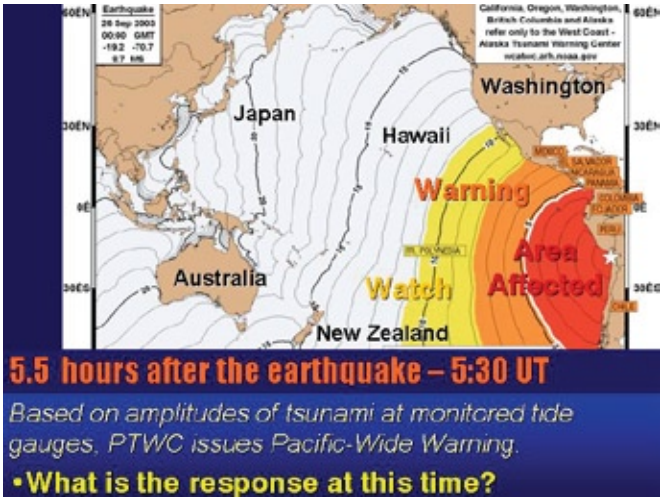


Figure 1. A panel session discussed the operational responses by tsunami warning centers and emergency agencies to a hypothetical M8.7 tsunamigenic earthquake off northern Chile.

Dr. Robin Falconer, Vice President Oceania, Circum-Pacific Council (CPC) and CPC Tsunami Special Project Chair, on CPC's intention to sponsor tsunami education/preparedness projects in the Pacific.

A two-hour interactive panel discussion was held on "Tsunami Warning Response to a M8.7 Chilean Earthquake" (Figure 1). The discussion involved the directors from Chilean, French Polynesian, Japanese and the Pacific Tsunami Warning Centers, State or National Emergency Management officials from Hawaii and Washington, USA, New Zealand and Australia, and researchers from Washington, USA, and New Zealand, and was moderated by Dr. Laura Kong, ITIC Director, and Ms. Gaye Downes, GNS Tsunami Programme. Five delegates (Russia (2), El Salvador, USA, Colombia) were sponsored by the IOC, while the Circum-Pacific Council sponsored four delegates (Ecuador, Papua New Guinea, Fiji, and Indonesia) to attend both the Workshop and ICG/ITSU conference. Locally, the Workshop was supported by the Earthquake Commission, Greater Wellington Regional Council, Wellington City Council, the Royal Society of New Zealand, the Ministry of Civil Defence and Emergency Management, the Institute of Geological & Nuclear Sciences, and the National Institute of Water and Atmospheric Research.

Recommendations

The workshop concluded with seven recommendations :

1. Historical data:
   - *Recommend continuing efforts to search for historical data at the regional and local levels, and to encourage their integration into the Pacific-wide historical database. A wealth of historical data on tsunami occurrence and manifestation exists in many governmental, institutional and historical archives, and scattered in numerous publications that are not readily available.*
   - *Recommend and encourage the support of systematic paleo-tsunami research, since these studies can provide extremely important estimates of the long-term tsunami risk for coastal locations where the historical record is short.*
   - *Recommend the systematic searches of recent sea level records for tsunami signals to improve our knowledge of the areas at risk. These data should be saved and copies sent to the ITIC for archiving.*
2. Regional TWS for SW Pacific and Indian Ocean:
   - *Recommend that Indonesia and other countries of the South-West Pacific proceed in the development of the Regional Tsunami Warning System for the SW Pacific and Indian Ocean with reference to the ITSU Master Plan for Further Development of the Pacific Tsunami Warning System. This will benefit not only countries of the region but will also enhance the ability of the PTWC to locate smaller earthquakes in this area and to assess their tsunami threat.*

WELLINGTON, *continued*

3. Deep-water tsunami observations:
   - *Recommend that every opportunity be used to further expand the network of deep-water instruments, which are providing important deep-ocean tsunami measurements to evaluate the tsunami threat and predict tsunami heights on the coastlines, and to integrate these data and interpretation methods into the operations of the PTWC.*
4. Availability of sea level data for operational warning:
   - *Recommend increasing the use, through the Internet, of the real time or near-real time sea level data from New Zealand stations and other areas in the South Pacific, for use by PTWC and for access by the scientific community.*
5. Technical Report on the Panel Discussion:
   - *Recommend that the records of the panel discussion on the responses of warning centers and emergency agencies to the issuance of tsunami warning messages for a major M8.7 earthquake off the northern Chile coast, which was very useful and productive, be converted into a Technical Report by GNS and NIWA, in collaboration with ITIC.*
6. Far-Field Tsunami Workshop in 2004:
   - *Recommend special ITSU workshop, possibly in conjunction with the VIII Earth Science Congress in Santiago, Chile, to discuss issues related to Pacific-wide TWS operations. Pacific-wide tsunami are rare. However, the risk of failure of prediction by the TWS, as well as the cost of false alarm, are very high due to the large number of countries and territories put into a warning status.*
7. Public Education and Awareness:
   - *Recommend developing and maintaining archives of tsunami public education and emergency management products for sharing and international consultation.*
   - *Further recommend that ITIC be consulted to facilitate an international archive.*

Figure 2. a. (above) From left to right, Emilio Lorca (SNAM Chile), Dr. Chip McCreery (PTWC), Dr. Dominique Reymond (CPPT), Noritake Nishide (JMA), Mike O'Leary (New Zealand Civil Defence), Dr. Linda Anderson-Berry (Australian Disaster Programme Coordinator), and Dr. Willem de Lange (New Zealand Tsunami Advisor). b. (right) From left to right, Dr. Frank Gonzalez (NOAA/PMEL), Noritake Nishide, George Crawford (Washington, USA Emergency Management), and Emilio Lorca.

ISDR EARLY WARNING CONFERENCE II

Bonn, Germany, 16-18 October 2003

The ITIC Director attended the Second International Conference on Early Warning – Integrating Early Warning into Public Policy (EWC-II) in Bonn, Germany, 16-18 October 2003, where she presented a paper on Global and Regional Tsunami Warning Systems highlighting the successes of ITSU and the Tsunami Warning System in the Pacific and the national warning systems in Japan and Hawaii. She also served as Rapporteur for the Good Practices session on Technological Means for Information Sharing. Over 300 participants, including ministers and government officials, representatives from the United Nations (UN) and other multilateral organizations, assistance agencies, technical and research institutions and non-governmental organizations, attended the meeting that was hosted by Germany and supported by the UN Inter-Agency Secretariat of the International Strategy for Disaster Reduction (ISDR). EWC-II built on regional consultations and workshops undertaken between May and July 2003, and served as a follow-up to the International Conference on Early Warning Systems for Natural

EWC II, *continued*

Disaster Reduction, held in 1998. Sessions focused on good practices in early warning and on emerging issues, and panels discussed solutions for integrating early warning into public policy, new technologies and low-technology solutions for early warning systems, the responsibilities of policy makers in the context of early warning and urban risks, and early warning as a decision tool for emergency management. Recommendations from EWCII and the Conference Statement, as well as the meeting summary, can be viewed at *http://www.iisd.ca/isdr/ewc2/*.

During the meeting, the ITIC Director also met with El Salvador ITSU National Contact Antonio Arenas and Americas Regional Consultation organizer Dr. Juan Carlos Villagran to discuss planned tsunami warning system assistance for Central America, UNESCO Engineering Sciences and Technology Section Chief Badaoui Rouhban to explore possibilities for increased support, Asian Disaster Reduction Center Executive Director Satoru Nishikawa on the potential for future tsunami mitigation collaboration with ITSU, and A. Djumarma Wirkusumah, Indonesian Volcanological and Geological Hazard Mitigation Directorate, to inform him on the planned implementation of a national tsunami warning system in Indonesia.

U.S. NATIONAL TSUNAMI HAZARD MITIGATION PROGRAM MEETING

Seattle, Washington, USA,
6-7 November 2003

Jeff LaDouce, NOAA/National Weather Service Pacific Region Director, U.S. Tsunami Program Manager, USA ITSU National Contact, 737 Bishop St., Suite 2200, Honolulu, HI 96813 USA, jeff.ladouce@noaa.gov

The U.S. National Tsunami Hazard Mitigation Program Steering Committee (NTHMP, *http://www.pmel.noaa.gov/tsunami-hazard/*) met on November 6 and 7, 2003 to discuss progress during the previous year and to identify projects for funding in FY2004. The meeting concluded with the transfer of Chairmanship of Steering Committee from Dr. Eddie Bernard, Director of the Pacific Marine Environmental Laboratory (PMEL) to Mr. Jeff LaDouce, Director, NOAA/NWS Pacific Region. The next meeting will be held 18-20 May 2004 in Anchorage, Alaska.

During FY2003 using NTHMP funds, the USGS made available in real-time, earthquake information where CREST stations had been deployed in Alaska, the West Coast and Hawaii (*http://quake.wr.usgs.gov/waveforms/crest/index.html*). The Earthquake Display

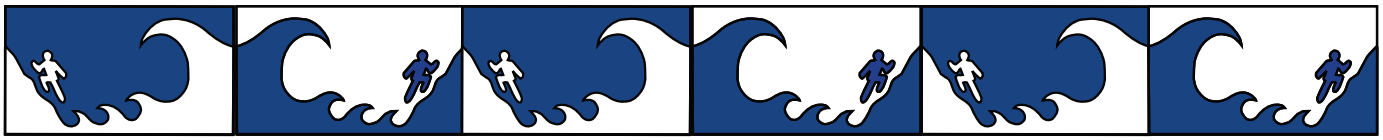
NTHMP, *continued*

project provides emergency responders and agencies with seismic display software to facilitate response after an earthquake. Customized maps will be developed for California, Oregon, Washington, Alaska, Hawaii, Puerto Rico, Guam, and the west coasts of Canada, the US, and Mexico. FEMA and NOAA, through the NTHMP, have begun work on tsunami-resistant design and construction guidance. The project will involve the review of relevant research and use of inundation mapping data and state-of-the-art technologies to develop design requirements for structures that would allow for vertical evacuations. The guidance will supersede FEMA's Coastal Construction Manual (FEMA-55) and has an expected completion date of 2005.

Fiscal year 2003 marked the transition of the Deep-Ocean Assessment and Reporting of Tsunamis (DART) Buoys from PMEL to the National Data Buoy Center. The beneficial impact of the DART buoys to tsunami warning operations was clearly shown during the November 17, 2003, M_W7.8 Rat Islands, Aleutian earthquake. The earthquake's seismic waves triggered the start of emergency data transmissions from the nearest DART buoy to the warning centers, which then monitored the passing of the tsunami waves. The data were received and analyzed in time to provide guidance to the West Coast / Alaska Tsunami Warning Center (WC/ATWC) in canceling their tsunami warning for their region, and to PTWC to not put Hawaii into a tsunami warning status.

The Fiscal Year 2004 budget for the NTHMP remained unchanged from the 2003 levels at USD $4.3 million. Mitigation and mapping efforts received over USD $1.3 million, seismic operations nearly USD $600,000, with the remainder going to modeling and the DART operations. The Steering Committee also funded a proof-of-concept project to Washington state to deploy NOAA Weather Radios for tsunami warning message dissemination.

A U.S. Tsunami Coordination Meeting will be held 2-4 March 2004 in Honolulu, Hawaii, to discuss tsunami warning operational procedures. The meeting will bring together staff from the PTWC, the WC/ATWC, Warning Coordination Meteorologists from the National Weather Service Alaska, Western and Hawaii Regions, and State Emergency Managers to discuss and identify ways to better coordinate the dissemination of and response to tsunami warnings.



TSUNAMI "FIRSTS" PRESENTED AT THE AMERICAN GEOPHYSICAL UNION MEETING San Francisco, CA, USA, 9-12 December 2003

Eddie Bernard, Director NOAA/PMEL,7600 Sand Point Way NE, Seattle, WA 98115-6349, Eddie.N.Bernard@noaa.gov

Thirty papers from ten different countries were presented in three sessions at the Fall meeting of the American Geophysical Union (AGU) on December 9, 2003 in San Francisco, California. In addition, three tsunami papers were presented during a special session on the September 25, 2003 Hokkaido earthquake/tsunami on Friday, 12 December. During these four sessions, three "firsts" in tsunami research and mitigation were presented. For the special session on the 2003 Hokkaido earthquake/tsunami, Dr. Kenji Hirata presented real-time data from two cabled Japanese tsunameters located in the area of earthquake deformation showing, for the first time, the "birth of a tsunami".

For the November 17, 2003 Alaska earthquake/tsunami, Dr. Eddie Bernard presented real-time data from a U.S. portable tsunameter (Deep-Ocean Assessment and Reporting of Tsunamis, or DART buoys) located about 900 km from the earthquake epicenter showing the deep ocean signal of the tsunami approaching Alaska and Hawaii. These data were used, for the first time, to assist in the decision to cancel a tsunami warning for the U.S. Dr. Vasily Titov presented, for the first time, the results of his real-time forecast for Hilo Bay using these portable tsunameter data from the Alaska event. Dr. Titov's results showed greater than 90% accuracy in amplitude and period for the first three waves. These results are paving the way for real-time tsunami forecasts.

A programmatic first for the U.S. were presentations by Juan Pestana of the National Science Foundation and Dr. Eddie Bernard of NOAA describing the partnership between the Network for Earthquake Engineering Simulations (NEES) and the National Tsunami Hazard Mitigation Program (NTHMP). Dr. Costas Synolakis presented an example of NEES-type research by describing the development of construction guidelines and standards for southern California marine terminals. Dr. Jose Borrero presented an example of NTHMP-type products by describing the development of tsunami inundation maps for California.

In addition, the WC/ATWC's Guy Urban presented new technology for measuring tide levels in harbors in real-time in Shemya, Alaska that looks promising as a low-cost coastal tsunami monitoring system. International tsunami mitigation activities were presented by Mexico's Dr. Salvador Farreras, Puerto Rico's Dr. Victor Huerfano, and Turkey's Dr. Ahmet Yalciner. Results from field surveys of the 2002 Stromboli, Italy and 2003 Hokkaido, Japan tsunamis were presented by Dr. Costas Synolakis and Dr. Yuichiro Tanioka, respectively. In short, the 2003 AGU was an opportune venue for presenting historic new firsts in tsunami research and mitigation to the global, earth sciences community.

Located in Honolulu, the International Tsunami Information Center (ITIC) was established on November 12, 1965, by the Intergovernmental Oceanographic Commission (IOC) of the United Nations Educational, Scientific, and Cultural Organization (UNESCO). In 1968, the IOC formed the International Coordination Group for the Tsunami Warning System in the Pacific (ICG/ITSU).

The present 26 Member States are: Australia, Canada, Chile, China, Colombia, the Cook Islands, Costa Rica, the Democratic People's Republic of Korea, Ecuador, El Salvador, Fiji, France, Guatemala, Indonesia, Japan, Mexico, New Zealand, Nicaragua, Peru, Philippines, the Republic of Korea, Samoa, Singapore, Thailand, the Russian Federation, and the United States of America.

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